THE PLANT DISEASE REPORTER

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PLANT DISEASE EPIDEMICS
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IDENTIFICATION SECTION

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PLANT DISEASE EPIDEMICS AND IDENTIFICATION SECTION

Horticultural Crops Research Branch Plant Industry Station, Beltsville, Maryland
Volume 40 December 15, 1956 Number 12

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A DEVICE FOR RECORDING THE DURATION OF DEW DEPOSITS

Carlton F. Taylor[1]

ABSTRACT

A device is described which records with high accuracy the starting time and the duration of dew deposits. Dew deposition on it is comparable to that on foliage under similar placement. The recording surface is a glass disc which is rotated by a 24-hour clock. An indelible pencil touches the disc and makes a conspicuous line only when the glass is wet. This instrument has proved to be dependable and rugged under field conditions.

INTRODUCTION

Knowledge of the period during which dew is present on plants is of prime importance in studies on the epiphytology of plant diseases. The most intensive study on this subject has been made in connection with apple scab (Venturia inaequalis). Here sufficient data were available so that Mills (4) was able to devise a chart to show the relationship between the period of wetting at various temperatures and the amount of infection that resulted. Extensive research by many workers on the late blight disease of Irish potato (Phytophthora infestans) has provided a fair definition of the general conditions controlling infection. Exact data are lacking on the number of hours of wetting necessary. Duvdevani et al. (2) observed that under arid conditions the presence of dew was essential to the extensive development of downy mildew of cucumber (Pseudoperonospora cubensis).

Determination of the effect of duration of moisture under field conditions has been handicapped by the lack of suitable instrumentation. Winters and Small (7) developed an automatic device to record moisture films by voltage transmission but the method has not been used widely. Zikeev (8) lists 36 publications dealing with the quantitative measurements of dew. Several of these papers discuss newly devised instruments of which only the specially painted block of Duvdevani (3) appears to have been employed in phytopathological studies. Recently Wallin and Polhemus (6) have described a device controlled by the varying tension of lamb gut to record the duration of dew.

DESCRIPTION OF THE DEW METER

Interest in the duration of moisture deposited on leaves as dew led to attempts to devise an instrument to record the duration of such deposits. Selection of the deposition surface is of prime importance for an instrument of this sort. Ideally, the device should actually record the formation of dew on leaves of the particular plant under study; however, the inherent physical difficulties involved in the use of leaf surfaces necessitated a search for a more durable and convenient material upon which dew deposition would occur at approximately the same time as on horizontally oriented leaves of most plant species. Of the materials tested, glass surfaces with an emissivity value of approximately 0.9 in the infrared proved most satisfactory. Black-painted surfaces possess a high emissivity value and provide good surfaces for dew deposition. However, none of the black paints so far tested survived cleaning so as to be reusable, and for this reason glass is preferred at present. Unpainted aluminum discs gave a delayed and erratic record.

The instrument that was finally developed is shown in Figure 1A. The dew deposition surface employed is a disc of ground glass approximately 8 inches in diameter. This disc rests on a turntable rotated once daily by a stem-wound clock mechanism. A hub in the center of the turntable drops over the drive shaft of the clock. A cross pin centered in the hub fits a slot in the drive shaft to provide a positive drive. A narrow slot in the edge of the glass disc fits over a small erect pin in the turntable to prevent slippage and to insure correct orientation of the disc at all times. For protection against rain and dust the clock is enclosed in a metal housing fastened to a metal base; a soft rubber gasket seals the junction. The edge of the turntable is turned downward to protect the housing openings for the drive shaft and access to the winding stem from splashing rain. At these openings soft rubber gaskets reduce the

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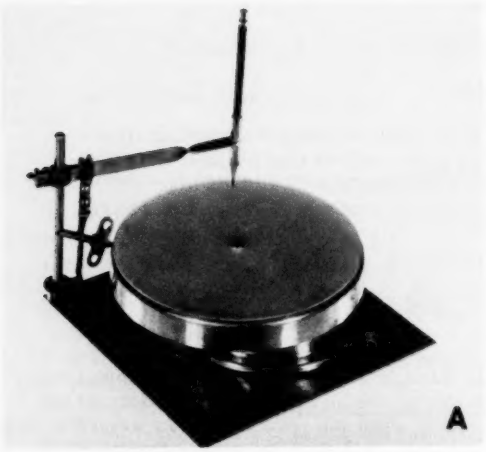

FIGURE 1A. The Taylor Dew Meter assembled and ready for use.

FIGURE 1B. A close-up view showing the initial portion of the dew record.

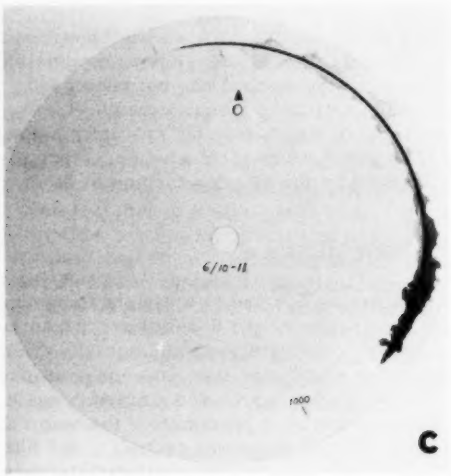

FIGURE 1C. A typical record indicating dew of approximately 9 1/2 hours duration. 0 position indicates midnight.

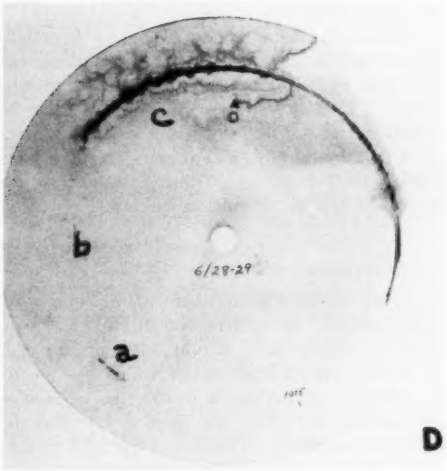

FIGURE 1D. A recording of moisture due to rain, indicating, (a) an afternoon shower, followed by drying (b), then (c) rain from approximately 8:10 P.M. to 12:50 A.M., remaining wet until 7:30 A.M.

entrance of water and dust. Additional weatherproofing such as a rubber gasket at the junction of the hub and the turntable, a rubber stopper in the top of the hub, and adhesive tape over the access hole to the stem wind extends the life of the clock. Commencing in 1954 the clocks, excepting the main spring, were dipped in "Cryscote", a rust inhibitor. This appears to have added considerably to the life of the clocks.

The presence of dew on the disc is recorded by means of dye dissolved from a sharpened Eberhard Faber Mongol Purple pencil (#994 or 844) supported in a vertical guide tube so that the point of the pencil rests on the ground glass surface. The guide tube is sufficiently large to permit the pencil to slide through freely and is supported by an arm attached to a post fitted into the base plate. When the surface is dry only a very faint line is marked as the disc rotates. In the presence of moisture the pencil is softened and a heavy line is deposited. As the moisture film evaporates, the pencil dries and resumes the trace markings. The position of the pencil point is marked with the time of daily disk change to provide a point of reference. The time of moisture deposition and of drying is determined by placing the glass disk over a circular 24-hour recorder chart. A convenient permanent record may be made by tracing the line on such a 24-hour circular chart printed on thin paper. This is particularly convenient when recording the occurrence of periods of intermittent dew or brief showers. The deposition disks should be changed each day, or if desired, the pencil may be moved to inscribe a circle of different diameter and thus record additional days. The glass disk may be cleaned readily by soaking in chlorinated bleach solution after which the loosened deposit can be washed away easily. It is convenient to have several disks so that cleaning need not be a daily chore.

INTERPRETATION OF RECORD

Some information as to the nature of the moisture deposition can be gained by an examination of the characteristics of the line. The faint line formed on the dry plate becomes increasingly heavy prior to the time at which the dew becomes visible. The length of this "previsible dew" line is related to the rapidity with which the ambient temperature approaches the dew point. This early line is characterized by a relatively smooth edge in contrast to the line formed when visible droplets are present (Fig. 1B). An increase in the dew deposition as the disk rotates brings the pencil in contact with droplets. The lateral flow of dye into these droplets results in a line with a "feathered" edge. To a considerable extent, the degree of "feathering" corresponds to the size of the droplets and the amount of free water on the plates. With dew alone, however, there remains a discrete and definite pencil mark that can be distinguished from the diffusion of the dye into the adjacent droplets. No quantitative scale for rating intensity of dew deposit is possible, however, since the dye deposit becomes increasingly heavy as the pencil softens with continued exposure to moisture (see Fig. 1C).

While this instrument was intended primarily to measure the duration of moisture films deposited as dew, it also records the deposition of moisture from any other source. The effect of rain is discernible as an erosion of the material deposited as the disk passes under the wet pencil. Any line formed prior to drying will be affected by the rain so that only the time of the ending but not of the start of a heavy rain can be determined (see Fig. 1D). Heavy rains will completely disperse the deposit and light rains and mists will cause a mark like that of dew.

PLACEMENT OF THE DEW METER

The placement of the meter in an experimental plot is important. The dew point is reached as radiant cooling lowers the air temperature to the point of moisture saturation. Owing to transpiration the air of the plant foliosphere carries an increased moisture content so that the dew point is reached and dew is formed more quickly among plant tops than over bare ground. Most satisfactory record of actual period of dew on plants is obtained when the meter is placed among dense plant growth near the top foliage level. It should be so placed that the surface is fully exposed to permit radiation. When the meter is placed over bare soil there is an appreciable delay in dew formation.

The time of dew deposition varies with plant species (1), with the angle of repose of the leaves of any plant with respect to the sky, and with the degree of exposure of the leaf in question. Leaves most exposed to the sky will be the first upon which dew forms. Consequently, the record formed on the dew meter, as described, will describe most accurately the dew formed on leaves of comparable orientation and exposure.

DISCUSSION AND ACKNOWLEDGMENT

The dew meter as described has been field-tested for several seasons under a wide variety of environmental conditions and found to record, with a high degree of accuracy, the time of dew deposition and the duration of dew. It is rugged and requires a minimum of daily attention. With the protective precautions described, the clocks have given more than one season's performance under all but the most adverse conditions. The clocks are replaceable. This dew meter is considered to be a practical item of field meteorological equipment for phytopathological investigation.

An application for patent was filed by the Federal Government in May, 1953, under the title "Dew Meter".

Several coworkers participated in the development of this device from the basic idea to the present model. Edward Cherry, Raymond Crum (deceased), and John Smoot were most helpful (Chemical Corps, Fort Detrick, Frederick, Maryland).

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THE EFFECT OF TIME OF ADDING SUSPENSIONS IN SOIL MYCOFLORAL ASSAYS[1]

K. D. Paharia and T. Kommedahl[2]

Many methods have been used to assay soil microorganisms and the soil dilution method has been the most widely used and most useful one (2, 4). Acid is often added to culture media to favor fungi; however, other bacteriostatic agents have proven effective also, e.g. crystal violet, rose bengal, oxgall, and streptomycin. Tyner (4) reports effects of media composition and chemicals that might be selective on soil microflora.

In this study 21 media were used to test the number and kind of fungi in soil by two different methods: 1) a known quantity of soil suspension was incorporated into the medium at the time of pouring, and 2) a 1-ml portion of a soil suspension was evenly distributed on the solidified agar surface of plates, 2 to 3 days after the agar was poured.

Ten grams of soil were added to 95 ml of water and shaken mechanically for 15 minutes at 20 rpm. One ml of this suspension was transferred to 9 ml of water, and from this dilution, 1 ml was transferred to 100 ml of water, which resulted in a dilution finally of 1:10,000.

One set of plates was prepared by pouring media into petri plates and incubating the sterile media for 2 days. Then the known amount of the final soil dilution was distributed over the surface of the 2-day-old media. The second set of plates was prepared by adding a known amount of the final soil dilution to the cooled (to 45° C), melted media immediately prior to pouring. Thus in the latter method, the soil dilution was incorporated into the medium and incubated.

Two aliquots were taken from the original soil suspension and three plates of each medium were used per treatment.

The media used are given in Table 1.

As evident in Table 1, 18 of the 21 media used gave higher averages of fungus colonies per plate when the soil suspension was pipetted onto 2-day-old media, as compared with incorporating the suspension at the time when plates were poured. The addition of rose bengal and streptomycin gave the highest readings when added to any of the media tried. Relatively low mold counts were obtained on malt-salt agar regardless of method of adding suspensions; however, this medium was developed to isolate xerophytic fungi from stored seeds, etc., where species of Aspergillus are prevalent (1). Upon averaging data from 21 media, higher counts were obtained on 2-day-old media, which proved to be highly significant (1 percent level) based on the "F" test for analysis of variance. However, it was found also that there were no significant differences between media at the 1 percent level based on the "F" test. While many media were tried and some differences were found, the essential point is that, regardless of medium, the addition of soil suspensions to the surface of agar generally gave higher numbers of colonies than did the addition of suspensions to media at the time of pouring agar.

The kinds of fungi encountered varied with the medium in either method, as reported earlier (3). Species of Alternaria, Cephalosporium, Chaetomium, Fusarium, Pythium, and Verticillium were favored by the addition of rose bengal or rose bengal and streptomycin; the same species were suppressed by acids and salts. Species of Aspergillus, Mucor, Penicillium, Rhizopus, and Trichoderma grew well on all media but did not spread in the presence of rose bengal or oxgall.

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[1] Paper No. 3633, Scientific Journal Series, Minnesota Agricultural Experiment Station.

[2] Formerly Research Assistant, Department of Plant Pathology and Botany, University of Minnesota, and Assistant Professor, Department of Plant Pathology and Botany, University of Minnesota.

Table 1. Average number of fungus colonies per plate when a soil suspension was incorporated with the medium at the time of pouring, compared to addition of the suspension to the surface of solid, 2-day-old-media, using 21 different formulations.

Principal ingredients of agar media	Colonies per plate when soil added[a]	
	At pouring	To 2 day old media[b]
Dox agar plus:		
rose bengal	6.3	21.7 **
rose bengal, streptomycin	8.7	24.7 **
yeast extract	6.7	7.3
yeast extract, streptomycin	12.7	17.7
yeast extract, lactic acid	8.3	11.7
yeast extract, rose bengal	15.7	31.7
yeast extract, rose bengal, streptomycin	17.7	32.3 **
Glucose-nitrate agar plus soil extract and:		
rose bengal	11.0	15.7
streptomycin	12.0	26.0 *
Malt (2 per cent)-salt agar:		
3 per cent NaCl	11.0	14.3
5 per cent NaCl	5.3	9.0
7 per cent NaCl	4.0	3.0
Peptone-dextrose agar plus:		
lactic acid	15.7	22.3 *
rose bengal	11.0	29.7 **
streptomycin	16.0	34.0 **
Potato-dextrose agar plus:		
lactic acid	8.7	19.7 *
rose bengal	18.5	29.3 **
rose bengal, streptomycin	18.9	39.7 **
yeast extract	5.3	4.3
yeast extract, streptomycin	18.3	9.7
yeast extract, lactic acid	5.3	14.3 *
Average	11.3	19.9 **

[a] Data based on averaging the number of colonies from 3-6 petri plates per aliquot of soil suspension. One or 2 aliquots of 10 g each were taken from soil samples, diluted (1:10), and shaken mechanically at 20 rpm for 15 minutes. Two final series of dilutions were prepared from each aliquot (1:10, 000 and 1:100, 000).

[b] Statistical analysis at the 1% (**) or at the 5% (*) levels, indicates the significant increase in numbers of colonies of fungi per plate between the 2 different times that soil suspensions were added.

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GREENHOUSE EVALUATION OF IN-THE-FURROW FUNGICIDES AT TWO TEMPERATURES AS A CONTROL MEASURE FOR COTTON SEEDLING NECROSIS

C. D. Ranney and L. S. Bird[1]

SUMMARY

Combinations and rates of five fungicides were tested at two soil temperatures as possible control measures for cotton seedling necrosis.

The data indicate that the majority of the fungicides do not give the same response at 70° and 80° F. Evidence indicates that temperature does not directly affect the fungicidal materials but rather that the effect is of changing the soil microflora.

Pre-emergence damping-off was more severe at 70° than at 80° F, while post-emergence necrosis was higher at 80° than at 70°.

Observations relative to the importance of the Fusarium phase of the seedling disease complex are noted.

Results of field tests where fungicides were applied in the seed furrow at planting time in an effort to reduce losses due to the cotton seedling disease complex have been variable. It has become apparent that treatments which give good control under some conditions may be completely ineffective under others. The accumulated field data (unpublished) indicate that it is necessary to control as many environmental factors as possible, especially temperature, in order to obtain a true understanding of the value of soil-applied fungicides. The purpose of this study was to determine the relationship between soil temperature, rate of fungicide application, and the development of cotton seedlings.

LITERATURE REVIEW

From the work of Fletcher (5), Britton-Jones (2), Shapovalov (11) and others, the concept has arisen that the seedling disease problem is actually a disease complex in which any one, or more, of several fungi may cause typical disease symptoms. This concept is supported by the work of Das (4) who isolated the following cotton seedling necrosing fungi from six typical cotton soils in Texas: Rhizoctonia solani Kuehn, Pythium debaryanum Hesse, Pythium ultimum Trow, and Pythium spp. and species of Fusarium. The particular pathogen or pathogens concerned cannot be determined by any peculiarity of the infection.

Richards (10) in 1921 was one of the first to call attention to the effect of soil temperature on Rhizoctonia infection, noting that the optimum temperature for infection of the potato was 18° C. Walker (12) in a detailed experiment observed that the optimum soil temperature range for the death of cotton seedlings due to seedling necrosis was from 17° to 23° C. Das (4), working with temperatures from 16° to 22° C, noted that higher infection occurred at the lower temperatures, and that the greatest symptom expression occurred near the minimum temperature range for seed germination and seedling growth. Das also noted that infection increased with increasing soil moisture, up to 75 percent of saturation. Walker's (12) experiments indicated that any soil moisture level at which cotton will grow is sufficient for invasion of the plants by the fungi, provided that the soil temperature is favorable. Kernkamp et al. (8) pointed out that soil moisture generally did not appear to have as much influence on the pathogenicity of R. solani as did soil temperature.

Arndt (1) found that certain fungicides afforded cotton seedlings significant protection from infection by R. solani during a 12-day culture period. Godfrey (7) applied fungicides at planting time to the soil above and around the cotton seed. Although the severity of damp-off was lowered by environmental conditions during the test, striking beneficial results were obtained with some of the fungicides used. Copper (3) stated that the application of fungicides at low rates to the seed furrow appears promising in the development of controls for cotton

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Table 1. Percent pre-emergence damping-off of cotton seedlings when the seed were covered with soil mixed with fungicides and grown at two temperatures.

Fungicides [a]	Pre-emergence damping-off (percent)		Mean
	70°F.	80°F.	
Vancide 51, 4 qts./A	43.0	34.0	38.5
Captan + PCNB + Zineb [b]	52.1	27.8	39.9
Captan 5#/A	59.0	25.7	42.4
Vancide 51, 6 qts./A	61.1	25.0	43.1
Dithane D-14 + $ZnSO_4$ [c]	60.4	32.7	46.5
Zineb 5#/A	58.4	34.7	46.5
Captan 7#/A	54.9	40.3	47.6
Control	78.3	39.6	58.9
Mean	57.2	32.5	44.8
L. S. D. for fungicides and temperatures .05	9.33	6.59	
.01	12.38	8.74	
L. S. D. for mean temperatures .05	3.30		
.01	4.38		

[a] The fungicidal-temperature interaction was significant at the .05 level.

[b] Respectively, 1 1/2, 1 1/2 and 2 pounds per acre.

[c] Respectively, 4 quarts and 3/4 pounds per acre.

Table 2. Percent emergence of cotton seedlings after 23 days when the seed were covered with soil mixed with fungicides and grown at two temperatures.

Fungicides [a]	Mean emergence (percent)		Mean
	70°F.	80°F.	
Vancide 51, 4 qts./A	57.0	66.0	61.5
Captan + PCNB + Zineb [b]	47.9	72.2	60.1
Captan 5#/A	41.0	74.3	57.6
Vancide 51, 6 qts./A	38.9	75.0	56.9
Dithane D-14 + $ZnSO_4$ [c]	39.6	67.4	53.5
Zineb 5#/A	41.7	65.3	53.5
Captan 7#/A	45.2	59.7	52.4
Control	21.7	60.4	41.1
Mean	41.6	67.5	54.6
L. S. D. for fungicides and temperature .05	8.95	6.27	
.01	11.88	8.45	
L.S.D. for mean temperature .05	3.18		
.01	4.22		

See Table 1, above for footnotes.

Table 3. Percent post-emergence damping-off of cotton seedlings when the seed were covered with soil mixed with fungicides and grown at two temperatures.

Fungicides [a]	Post-emergence damping-off (percent)		Mean
	70°F.	80°F.	
Captan + PCNB + Zineb [b]	0.70	0.70	0.70
Dithane D-14 + $ZnSO_4$ [c]	0.00	1.40	0.70
Zineb 5#/A	1.40	2.08	1.74
Captan 5#/A	0.70	4.87	2.78
Vancide 51, 4 qts./A	0.70	6.95	3.83
Vancide 51, 6 qts./A	4.18	10.42	7.30
Captan 7#/A	1.40	14.58	7.99
Control	2.77	13.88	8.33
Mean	1.48	6.86	4.17
L. S. D. for fungicides and temperatures .05		7.80	5.51
L. S. D. for fungicides and temperatures .01		10.35	7.31
L. S. D. for mean temperatures .05		2.75	
L. S. D. for mean temperatures .01		3.64	

[a] The fungicide-temperature interaction was significant at the .05 level.

[b] Respectively, 1 1/2, 1 1/2, and 2 pounds per acre.

[c] Respectively, 4 quarts and 3/4 pounds per acre.

Table 4. Percent final stand of cotton seedlings when the seed were covered with soil mixed with fungicides and grown at two temperatures.

Fungicides [a]	Final Stand (percent)		Mean
	70°F.	80°F.	
Captah + PCNB + Zineb [b]	47.22	71.52	59.37
Vancide 51, 4 qts./A	55.57	59.03	57.30
Captan 5#/A	40.26	70.15	55.21
Dithane D-14 + $ZnSO_4$ [c]	39.60	67.35	53.48
Zineb 5#/A	40.26	63.20	51.73
Vancide 51, 6 qts./A	34.73	62.50	48.62
Captan 7#/A	43.75	45.83	44.79
Control	18.75	47.22	32.98
Mean	40.02	60.85	50.43
L. S. D. for fungicides and temperatures. .05		9.62	6.81
L. S. D. for fungicides and temperatures. .01		12.75	9.03
L. S. D. for mean temperatures .05		3.40	
L. S. D. for mean temperatures .01		4.51	

[a] The fungicide-temperature interaction was not significant.

[b] Respectively, 1 1/2, 1 1/2, and 2 pounds per acre.

[c] Respectively, 4 quarts and 3/4 pounds per acre.

Table 5. Mean disease grades of cotton seedlings when the seed were covered with soil mixed with fungicides and grown at two temperatures.

Fungicides [a]	Mean disease grade [b]		Mean
	70°F.	80°F.	
Captan + PCNB + Zineb [c]	4.06	3.21	3.64
Captan 5#/A	4.35	3.21	3.78
Vancide 51, 4 qts./A	3.86	3.81	3.83
Dithane D-14 + $ZnSO_4$ [d]	4.42	3.55	3.98
Zineb 5#/A	4.50	3.66	4.07
Captan 7#/A	4.19	4.18	4.19
Vancide 51, 6 qts./A	4.79	3.81	4.30
Control	5.19	4.00	4.60
Mean	4.42	3.68	4.05
L. S. D. for fungicides and temperatures .05	0.58		0.41
.01	0.77		0.55
L. S. D. for mean temperatures .05	0.21		
.01	0.27		

[a] The fungicide-temperature interaction was significant at the .05 level.

[b] Grades: 1, no disease; 2, single lesion less than 3 mm long; 3, single lesion less than 6 mm long; 4, severely diseased, not girdled; 5, girdling lesion, not dead; 6, dead or seedling not emerged at end of 23 days.

[c] Respectively, 1 1/2, 1 1/2 and 2 pounds per acre.

[d] Respectively, 4 quarts and 3/4 pounds per acre.

Table 6. The vigor of cotton seedlings as measured by mean height when the seed were covered with soil mixed with fungicides and grown at two temperatures.

Fungicides [a]	Mean height in centimeters		Mean
	70°F.	80°F.	
Captan 5#/A	5.85	7.94	6.89
Vancide 51, 4 qts./A	6.15	7.24	6.69
Captan 7#/A	5.71	6.94	6.33
Captan + PCNB + Zineb b	5.26	7.39	6.32
Zineb 5#/A	4.45	7.41	5.93
Vancide 51, 6 qts./A	4.31	6.98	5.65
Control	3.35	7.83	5.59
Dithane D-14 + $ZnSO_4$ c	3.10	6.72	4.91
Mean	4.77	7.30	6.04
L. S. D. for fungicides and t emperatures .05	1.09		0.78
.01	1.45		1.03
L. S. D. for mean temperatures .05	0.40		
.01	0.53		

[a] The fungicide-temperature interaction was significant at the .01 level.

[b] Respectively, 1 1/2, 1 1/2 and 2 pounds per acre.

[c] Respectively, 4 quarts and 3/4 pounds per acre.

Table 7. The average ranks of fungicides as determined by six measurements (pre-emergence damping-off, emergence, post-emergence damping-off, final stand, disease grades, and seedling vigor) on cotton seedlings when the seed were covered with soil mixed with fungicides grown at two temperatures.

Fungicides [a]	Average rank for the six measurements [b]		Mean
	70°F.	80°F.	
Captan + PCNB + Zineb [c]	2.3	2.2	2.25
Captan 5#/A	3.7	2.0	2.83
Vancide 51, 4 qts./A	1.2	5.0	3.08
Zineb 5#/A	4.3	4.2	4.25
Dithane D-14 + $ZnSO_4$ [d]	5.2	3.5	4.33
Vancide 51, 6 qts./A	6.3	4.0	5.08
Captan 7#/A	3.0	7.7	5.33
Control	7.0	5.8	6.42
L. S. D. .05	1.60		1.13
.01	2.13		1.50

[a] The fungicide-temperature interaction was significant at the 0.1 level.

[b] Calculated as the average of the numerical ranks of fungicides for six measurements.

[c] Respectively, 1 1/2, 1 1/2 and 2 pounds per acre.

[d] Respectively, 4 quarts, and 3/4 pounds per acre.

Table 8. Relative proportions of seedlings infected with R. solani, Fusarium spp. and Pythium spp. at two temperatures.

Organism	Percent infected seedlings at:	
	70°F. [a]	80°F. [b]
R. solani	33.0	0
Fusarium spp.	50.0	99.0
Pythium spp.	17.0	1.0

[a] Based on 108 seedlings collected 23 days after planting.

[b] Based on 121 seedlings collected 23 days after planting.

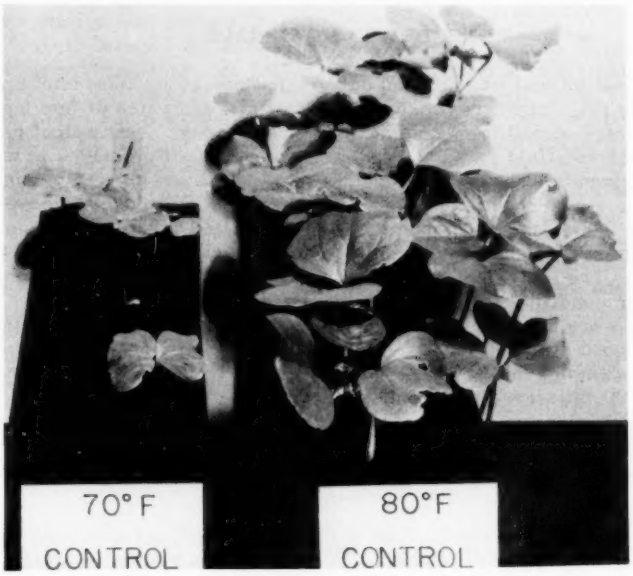

FIGURE 1. The effect of temperature on seedling emergence and severity of cotton seedling necrosis.

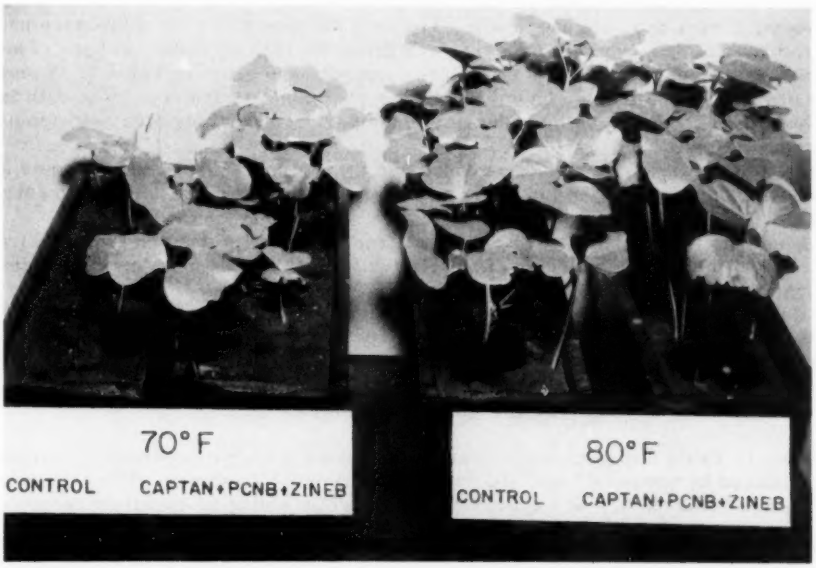

FIGURE 2. The effect of the fungicide mixture of 1 1/2 pounds captan + 1 1/2 pounds PCNB + 2 pounds zineb, compared with control, at 70° and 80° F.

stand failures caused by soil-inhabiting pathogens.

METHODS AND MATERIALS

The fungicide evaluation test was carried out in a battery of constant temperature tanks as described by Ranney (9). Eight treatments (combinations and rates of five fungicides) were replicated four times at soil temperatures of 70° and 80° F, their selection being based on the results of unpublished field data collected at this station. Fungicides in the amount corresponding to that given in Table 1 were added to a weighed amount of Houston clay soil and thoroughly mixed in a cement mixer. The treated soil was then used to cover the seed. Planting depth of 1 1/2 inches and seed spacing were controlled by the method described by Ranney (9). Acid-delinted Ceresan-treated seed with 90 percent germination of the variety Deltapine 15 was used. The individual pans were watered daily to obtain, as nearly as possible, similar moisture conditions.

Six measurements were used for obtaining information on the relative efficiency of the treatments in giving a good stand of healthy, vigorous cotton seedlings. These measurements were: pre-emergence damping-off, emergence 23 days after planting, post-emergence damping-off, final stand, disease grades and seedling vigor. All measurements were based on the stand 23 days after planting. The percentage data were transformed to degrees before being analyzed statistically.

RESULTS

The data for the treatments at 70° and 80° F soil temperatures for the six measurements are given in Tables 1 through 6. It is important to note that the fungicide-temperature interactions in each measurement with the exception of final stand are significant. This suggests that some fungicides are not acting in the same way at different temperature levels.

After observing these data, it should be noted that in Table 1 pre-emergence damping-off was greater at 70° than at 80° F, while the data in Table 3 shows that post-emergence damping-off was higher at 80° than at 70°.

In order to obtain an index to indicate the average efficiency of the treatments over the six measurements, a rank analysis was made. The best average value for a measurement was assigned the rank of one, while the poorest was given the highest rank. In case of a tie equal ranks were assigned. The results of the rank analysis are given in Table 7. These data show that only one of the treatments, captan + PCNB + zineb, gave good results at both temperatures. These data show that both the fungicide-temperature and fungicide rate-temperature interactions are significant.

The effect of temperature alone on emergence and the severity of seedling necrosis are shown in Figure 1. The effect of the fungicide mixture, captan + PCNB + zineb, compared with the control at 70° and 80° F is shown in Figure 2.

Emerged seedlings from the controls were taken from the test for the two temperature levels, cultured, and the fungi identified. The relative frequencies of fungi present at the two temperature levels are given in Table 8.

From the data presented in Table 6, it appears that at 70° F several of the fungicidal materials used give a significant beneficial effect on hypocotyl elongation. This response was not present at the 80° level.

DISCUSSION AND CONCLUSION

From the data in Table 7 it is apparent that the response of cotton seedlings to fungicides is markedly influenced by temperatures, the captan-PCNB-zineb treatment giving the most consistent response. Vancide 51, at 4 quarts per acre, while giving an excellent response at 70° F, ranks almost as high as the check at 80°. On the other hand, captan at 5 pounds per acre gave the best control at 80° but was significantly lower than the best treatment at 70°. Although seedling necrosis under field conditions is usually more prevalent at lower temperatures, a fungicide which gives a uniform response over a wide temperature range would be more desirable than one which is efficient only through a limited temperature range. This variation of response at different temperatures may be one of the main causes of the inconsistency of data collected from field plots.

It would appear that a fungicide or mixture of several fungicides that would give a known response over a range of temperatures would be of value in field work, tending to remove one

of the variables and permitting a more accurate estimate of fungicide effectiveness on different soil types and moisture conditions.

The relationship between pre-emergence and post-emergence damping-off as affected by temperature is also of interest. In Table 1 it is apparent that pre-emergence damping-off is much more severe at 70° than at 80° F regardless of treatment, while Table 3 shows that in the case of post-emergence damping-off the reverse is true, that is, post-emergence losses are more severe at 80° than at 70°. A check of the organisms present in the seedlings in the control pans (Table 8) shows that at 80° Fusarium spp. dominates the disease picture, while at 70° Rhizoctonia solani, Pythium spp., and Fusarium spp. were all active.

In most cases where the disease was reduced by fungicide treatment, R. solani and Pythium spp. were not recovered by culturing, but all the diseased seedlings yielded species of Fusarium. This indicates that some of the treatments were controlling the Pythium-Rhizoctonia phase of the seedling disease complex, or nearly so, but were not effectively controlling the Fusarium phase. The difference in temperature (Table 3) appears to be the main reason for the predominance of Fusarium at 80° F. There is the possibility that at 80° the fungicides applied reduced the normal soil-borne organisms antagonistic to Fusarium spp., thus permitting increased activity of the pathogens.

The results reported here, and other, unpublished, field data indicate that in Texas Fusarium spp. are possibly of more importance in the cotton damping-off complex than R. solani or Pythium spp. Therefore, it is necessary that a fungicide or a combination of fungicides highly toxic to Fusarium spp. as well as to the Pythium-Rhizoctonia phase, be used for in-the-furrow applications for controlling the cotton seedling disease complex. As pointed out by Fulton et al. (6), to be effective a material must act on not one or two but on all organisms which might conceivably injure the cotton seed or seedling.

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WEED AND ROOT KNOT CONTROL IN TOBACCO PLANT BEDS BY SURFACE DRENCH AND OTHER TREATMENTS

T. W. Graham[1]

Summary

Surface drench applications with Vapam, Mylone, and N521 used alone and in combination with calcium cyanamid gave effective weed and nematode control in tobacco plant beds during 1955 and 1956 tests. There was no stunting or other adverse effect on tobacco plants at two experimental plant bed locations. However, at one of three locations in cooperative trials with growers in 1956, tobacco plants were retarded following treatment with Vapam and N521. There was no apparent relation to physical conditions of the soil or to cropping history where stunting occurred. Weed control was good at two of the three grower locations.

Chemical treatments are successfully used by tobacco growers for control of weeds and root-knot nematodes (Meloidogyne spp.), two of the major plant bed problems in the southeastern tobacco areas. Studies of various soil amendments for this purpose have been followed in South Carolina for a number of years (1). Surface drench applications with Vapam and N521 (Stauffer Chemical Company), and Mylone (Crag 974, Carbide and Carbon Company), gave effective weed and nematode control in preliminary trials. Soil treatments in Florida with Vapam were reported by Magie (4) as fungicidal against Stromatinia gladioli. Taylor (5) reported Vapam as a promising herbicidal-fungicidal treatment in tobacco plant beds in Connecticut. Lautz (2) reported Vapam (Stauffer N-869) as fungicidal against tobacco black shank (Phytophthora parasitica var. nicotianae) in soil treatments in greenhouse experiments. Lear (3) secured effective control of root-knot nematodes with surface drench treatments in greenhouse flats.

Tobacco plant beds were treated with these and other soil amendments in comparative trials in 1955 and 1956. Bed areas were prepared by plowing, disking, and leveling during September or October and after treating were left undisturbed until the following January, at which time fertilizer was worked lightly into the top 1 to 2 inches of soil. Beds were then seeded. Soil temperatures for 2 weeks following treatment were in the general range of 60 to 70° F as indicated by soil thermograph records. Materials applied as surface drenches were suspended or dissolved in water in a 3-gallon sprinkler can and dispersed at the rate of 1 gallon of water per square yard. Injected liquids were placed 6 inches deep with a soil applicator and spaced in a 12 x 12-inch measured pattern. In treatments that were combined with calcium cyanamid, the latter was first mixed with the soil 2 to 4 inches deep. Surface drenches were then applied as above, 2 to 4 days after calcium cyanamid. In combinations with Vapam or Mylone, these were applied as a surface drench following calcium cyanamid. Methyl bromide gas was released under a polyethylene plastic cover left over the treated area for 48 hours.

Table 1 presents data from 2 years' trials at one location at the Pee Dee Experiment Station at Florence. The plant bed area had a dark organic soil and the location was a well-protected moist woods representing a plant bed site frequently used in South Carolina. Natural weed populations were low owing to the protected woods area. The soil had only traces of root-knot infestation; therefore, this location was not used to evaluate root-knot control. Significant data were obtained on weed control, tobacco plant stands, yield of transplants, and overall effect on plant growth. Results in Table 1 show that tobacco stands were generally lower in 1956. This was largely due to the lower seeding rate used that year. During both years plant stands in treated plots were equal to or better than in untreated plots. In 1955 Vapam or Mylone combined with calcium cyanamid gave satisfactory weed control and plant yields, as did the combination of calcium cyanamid with ethylene dibromide (W40). Each of these except the Mylone-cyanamid combination was comparable in plant yields to methyl bro-

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Table 1. Tobacco plant bed soil treatment for chemical control of weeds and root knot on dark organic soil.

Treatment	Pounds per 100 sq. ft. Active	Tobacco Plant Stands		Weeds per sq. ft.		Plant Yields sq. ft.	
		1955[a]	1956[b]	1955	1956	1955	1956
Methyl bromide gas	1.0	99	51	0.6	0.7	39	30*
Calcium cyanamid and ethylene dibromide (W40)	11.0 20 gals/acre	100	--	0.3	--	34	--
N521 (surface drench)[c]	1.0	110	58	0	0.6	29	34**
Mylone (974) (surface drench)[d]	1.0	--	42	--	0	--	29*
Mylone and Calcium cyanamid	1.0 5.5	77	--	0	--	20	--
Vapam[e] and Calcium cyanamid	1.0 5.5	117	--	0	--	32	--
Vapam (injected)	1.0	--	48	--	5	--	31*
Vapam (surface drench)	1.0	99	47	4	0	22	26
Control (untreated)	--	47	50	26	33	18	21
L. S. D. 5%		n.s.	n.s.	-	-	-	8.4
1%		n.s.	n.s.	-	-	-	10.4

[a] The 1955 data are averages from duplicate plots each 16 sq. yds. in area.

[b] The 1956 data are averages from 4 replicated and randomized plots each 5.6 sq. yds. in area.

[c] 3, 5, Dimethyltetrahydro - 1, 3, 5, 2, H-thiadiazine-2-thione.

[d] Same as N521.

[e] Sodium N methyl dithiocarbamate dihydrate (formerly N869).

mide. Methyl bromide has consistently been a most satisfactory combination herbicidal-nematocidal treatment.

In 1956 these combinations were not repeated, but further trials with Mylone, N521, and Vapam, each used alone, gave satisfactory weed control and plant yields, comparing favorably with results from methyl bromide. Injected Vapam (12 x 12-inch spaced applications) gave satisfactory plant yields, but not always good weed control (Table 2). Plant growth was not retarded following treatment with Vapam, Mylone, or N521 used in combination with cyanamid in 1955 or used alone in 1956; on the contrary, tobacco plants in most cases showed more vigorous growth and were somewhat larger than those grown in methyl bromide-treated or in the untreated plots. In 1956 there were significant increases in plant yields from plots treated with methyl bromide, Mylone, N521, and injected Vapam above yields from untreated plots. The relatively lower plant yields from the Vapam drench plots was in part due to a location effect where water stood long enough on a portion of the beds to cause reduced stands. Injected applications of DCB 60 or surface drench with PRD failed in weed control, but the former had some nematocidal value.

A second plant bed location with sandy loam soil was used in further trials. This bed site was located near a greenhouse and was therefore partially protected from winds. Otherwise, the area was open. Root-knot nematode infestation and weed populations were maintained at a relatively high level so that the most significant information from this area was on weed and nematode control together with effects on plant stands. Plant yields were not recorded. Results are presented in Table 2. Surface drench treatments with Vapam gave effective weed

Table 2. Chemical soil treatments on tobacco beds in a sandy loam soil[a].

Treatment	Pounds per 100 sq. ft.	Tobacco Plants per sq. ft.		Weeds per sq. ft.		Root Knot Index	
		1955	1956	1955	1956	1955	1956
Vapam (surface drench)	0.5	78	--	4	--	5	--
Vapam (surface drench)	1.0	--	47	--	4	-	0
Vapam (surface drench)	2.0	--	32	--	2	-	0
Vapam (injected)	1.0	--	38	--	22	-	0.6
Mylone (surface drench)	0.6	69	66	2	3	0.7	4.2
Mylone (surface drench)	2.0	--	47	--	4	-	0
N521 (surface drench)	0.6	61	39	2	2	3.7	1.1
N521 (surface drench)	1.9	--	37	--	3	-	0.5
DCB 60[b] (injected)	30 gal/a	--	21	--	70	-	5.6
PRD[c] (surface drench)	15 lbs/a	--	26	--	77	-	55.8
Control (untreated)	--	81	18	75	126	10.0	42.0

[a] Treated plots were in duplicate, each 20 sq. ft. in area. Counts of tobacco plants and weeds were made from four readings from each plot. One reading consisted of counts on all tobacco plants and weeds within a one sq. ft. area. Averages here are from 2 series of readings on February 28 and March 27. Root knot readings were taken May 22. 0=no root knot, 100 = maximum root knot.

[b] Mixture of dichlorobutenes.

[c] Composition not revealed.

Table 3. Chemical treatment for weed control in tobacco beds in cooperative trials with growers, 1956.

Treatment and Dosage	Cooperator and Plant Counts						Average	
	Drew		Jones		Rogers			
	Weeds sq.ft.	Tobacco sq.ft.	Weeds sq.ft.	Tobacco sq.ft.	Weeds sq.ft.	Tobacco sq.ft.	Weeds sq.ft.	Tobacco sq.ft.
Vapam 1 lb. 100 sq. ft.	21	74	3	27	1	29	8.3	43.3
Vapam 2 lbs. 100 sq. ft.	8	78	3	20	0	28	3.6	42.0
N521 0.74 lbs. 100 sq. ft.	24	100	5	29	0	27	9.6	52.0
N521 1.4 lbs. 100 sq. ft.	15	98	3	36	0	14	6.0	49.3
Control (No treatment)	58	61	50	23	31	29	46.3	37.6

and root knot control at both rates of 1 and 2 pounds per 100 square feet. Injected Vapam gave good nematode control but was not satisfactory in weed control. Mylone was effective in both respects at the 2-pound dosage rate but was less so at 0.6 pounds. N521 gave essentially the same results at comparable dosages. N521 and Mylone are reported to have the same active chemical composition. Trials here showed them to possess much the same values as herbicides; Mylone, however, was a slightly better nematocide in 1955, but the reverse was true in 1956. The differences, however, are small and probably not significant.

During 1956 additional trials with Vapam and N521 were conducted in cooperative tests with tobacco growers in three counties in South Carolina. All were surface drench treatments applied in October and November 1955, as already described. The information from these treatments consisted of weed and plant stand counts and observations on early plant growth. Results are shown in Table 3. At the Drew location weed control was not satisfactory, although Vapam at the 2-pound rate gave fair control. The procedure at this location was immediate application of the drench after the soil was turned with a tractor-drawn disk and then raked level by hand. The soil was a dark organic type. Tobacco stands were better in the treated beds (74 to 98 per square foot) than in untreated (61 per square foot). The Jones location, also a dark organic soil, was prepared several weeks in advance of treatment. Weed control here was satisfactory. The two rates of Vapam gave the same weed control, but with N251 1.4 pounds were better than 0.73 pound. With one exception, plant stands were best in treated plots. None of the treatments at these locations showed retarded growth of tobacco plants.

At the Rogers location, unlike all other treated locations, growth in all treated beds was severely retarded. Stunting was somewhat more severe with N521 than with Vapam. This location was in an unprotected open area with a sandy loam soil. Beds were prepared well in advance of treatments. Treatments were applied November 2. The first rains were 0.46 inch on November 11 and 0.86 inch on November 20. Total rainfall for November was 2.52 inches. Lear (3) stated, "It appears that if this chemical [Vapam] is added to saturated soil it is retained in the surface unless additional water is added to carry it throughout the soil mass." The soil at the Rogers location was not saturated either when treated or during the following 9 days; therefore this factor apparently was not involved. Other possible factors responsible for the retarded growth observed at the Rogers location did not appear to be related to the physical condition of the soil as compared with the four remaining locations where no stunting occurred.

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HOT-WATER TREATMENT FOR THE CONTROL OF ROOT-KNOT NEMATODES ON DIOSCOREA FLORIBUNDA

Walter O. Hawley[1]

INTRODUCTION

In the process of developing a crop for the production of cortisone in the United States, a large number of species of Dioscorea have been placed in cultivation at the U. S. Plant Introduction Garden at Glenn Dale, Maryland. A number of these Dioscorea accessions contain diosgenin, the drug precursor, or primary substance, derived from the tuber-like roots of this plant.

The work with Dioscorea at Glenn Dale includes the maintenance of basic collections, propagation of high-yielding accessions, and the provision of young plants for field test areas in the South.

CONDITION

It was noted at Glenn Dale that a group of 1000 plants of Dioscorea floribunda under bench culture failed to grow normally. Vines died back and new growth appeared to be inhibited even though dormancy had been broken and the growing season was underway. Inspection of the roots of these plants revealed a severe infestation by a mixed population of Meloidogyne spp., root-knot nematodes. The population was made up largely of M. javanica, but some M. arenaria and M. incognita acrita were present[2]. The fleshy roots were heavily galled and in many instances partly or completely rotted.

METHODS

According to Young[3] hot-water treatment was effective in the control of this type of nematode on colocasia roots. The same treatment was applied to the dioscorea roots.

Six hundred and fifty finger-size roots in varying stages of infestation were used for the test. Of this number, six heavily galled roots were left untreated to be used as untreated check inoculum on tomato indicator plants. The remaining 644 roots were immersed in a constant-temperature bath at 123.8° F (51°C) for 30 minutes. Six heavily infested roots of the treated material were retained for check inoculum to be tested with the untreated material.

As a test of the effectiveness of the hot-water treatment, the six heavily infested roots of the treated material were chopped into small pieces and mixed together. This mass of inoculum was then divided into ten equal parts, each of which was placed in a 6-inch pot half filled with sterile soil. A Marglobe tomato seedling was then planted in each pot. The six untreated roots saved for check inoculum were handled the same way so that the test included 20 tomato plants, half of which were grown in soil inoculated with treated dioscorea root tissues and the other half in soil inoculated with untreated root tissues containing live nematodes. The 20 pots were then placed on an isolation bench so that there could be no contamination from one set to the other. All precautions were taken to prevent contamination by other means.

RESULTS

After 8 weeks the tomato plants were removed from the pots and photographed (Figs. 1 and 2). There was a noticeable deficiency of top growth of the plants grown in untreated inoculum. This, of course, is directly attributed to the root damage resulting from the nematode infestation derived from the inoculum. In contrast, the plants grown in the treated inoculum were larger and there was only a trace of root-knot on the roots of one plant.

All the treated dioscorea roots except those used for treatment check were planted in flats filled with sterile soil pending the outcome of the inoculum test. Two weeks after the treatment,

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[2] Identification of nematode species by Nematology Section, Horticultural Crops Research Branch, Agricultural Research Service, United States Department of Agriculture.

[3] Young, R. A. The dasheen ---. U. S. Department of Agriculture, Farm. Bul. 1396. Rev. 1936.

FIGURE 1. Top growth of indicator plants (Marglobe tomatoes). Left -- plants grown in soil containing hot-water treated inoculum. Right -- grown in soil containing untreated inoculum.

FIGURE 2. Roots of indicator plants (Marglobe tomatoes). Top -- grown in soil containing hot-water treated inoculum. Bottom -- grown in soil containing untreated inoculum.

these roots were sprouting and beginning to produce healthy and vigorous top growth. Previous to treatment, many were rotted at the neck where they normally produce new shoots, but post-treatment growth was initiated wherever healthy tissues remained. Thirty-five percent of the roots treated failed to survive. However, most of the failures were nearly dead before treatment.

This work is considered a trial experiment to be repeated with elaboration at a later date.

HORTICULTURAL CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

NEW HOST RECORDS OF THE CITRUS NEMATODE IN CALIFORNIA

D. J. Raski, S. A. Sher, and F. N. Jensen

Summary

Two vineyards of Emperor variety of the commercial grape, Vitis vinifera, in Tulare County, California have been found parasitized by the citrus nematode, Tylenchulus semipenetrans Cobb, 1913. Lilac, Syringa vulgaris, and persimmon, Diospyros lotus, are also reported to be heavily infected by this nematode on the Citrus Experiment Station. Citrus nematode also was found parasitizing roots of persimmon in nine of ten samples from five localities in Southern California.

Two new hosts of the citrus nematode, Tylenchulus semipenetrans Cobb, have been found in California. The Emperor variety of the commercial grape, Vitis vinifera, and lilac, Syringa vulgaris, are added to persimmon, which was reported earlier this year by Nesbitt (2). Goodey and Franklin (1) have also listed Vitis vinifera as a host of T. semipenetrans, citing a report by Seinhorst and Sauer which is still in press.

In June of this year the senior author identified larvae of citrus nematode in soil samples collected by Mr. F. N. Jensen, Farm Advisor of Tulare County. These samples were taken from plants showing extremely poor growth in two areas of an Emperor vineyard belonging to R. C. Walters and located near Exeter. Besides larvae of T. semipenetrans, specimens of the following nematodes were also recovered from the soil: Meloidogyne incognita var. acrita, Pratylenchus vulnus, Xiphinema index, and Criconemoides xenoplax.

Later, in September, additional samples of roots and soil were taken from this vineyard, including roots of a number of weeds as well as of the Emperor grapes. The Department of Botany at Davis identified the plants as hairy crabgrass (Digitaria sanguinalis), watergrass (Echinochloa crusgalli), carpet-weed (Mollugo verticillata), American black nightshade (Solanum nodiflorum), tumbling pigweed (Amaranthus graecizans), nettle-leaf goosefoot (Chenopodium murale), lowland purslane (Portulaca oleracea), groundcherry (Physalis sp.).

Larvae, males, and adult females of the citrus nematode were recovered from the Emperor grape roots but none from the other plants.

This land was not cultivated until 1917, when plums were planted. The plum trees were removed in 1922 and the land replanted with the present Emperor vines, which are on their own roots. Immediately west of this planting is a 25-year-old navel orange orchard. The same cultivation equipment is not used in both, but the orchard and vineyard do share a common avenue.

Another record of citrus nematode in Tulare County was found later in September in an Emperor vineyard belonging to Dave Gilmore near Lindcove. Soil samples from this vineyard contained citrus nematode larvae as well as Xiphinema americanum, Pratylenchus thornei, Pratylenchus sp., and Rotylenchus sp. These vines, which are also infested with phylloxera, were planted about 10 years ago following another vineyard. There has been no history of citrus or olives being planted in either the Walters or Gilmore properties.

It is not possible to conjecture as to whether the citrus nematode is the cause of serious injury to these vines in view of the presence of other nematode species and of phylloxera. Cross inoculation tests are in progress to determine the susceptibility of other grape varieties to this nematode, and further tests are planned to measure the effects of citrus nematode on the growth of grapevines.

The citrus nematode also was found parasitizing the roots of lilac, Syringa vulgaris, and persimmon, Diospyros lotus, at the Citrus Experiment Station, Riverside, in samples collected December 12, 1955 by O Clarke and A. Bell. Inoculation tests were undertaken, using 25 grams of persimmon roots infected with citrus nematode placed in clean soil in gallon crocks which were planted to sweet orange seedlings. All the seedlings became infected.

Further sampling in Southern California showed citrus nematode in nine of ten samples of persimmon roots collected in Riverside, San Bernardino, Rialto, Sunnymead and Pala. Lilac roots have only been collected once and it is not known how widespread citrus nematode is on this host.

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THE STING NEMATODE, BELONOLAIMUS GRACILIS, FOUND IN NEW JERSEY

M. T. Hutchinson and J. P. Reed

Two fields on a farm near Masonville (Burlington County), New Jersey, were found to be heavily infested with sting nematodes. The nematodes were identified as Belonolaimus gracilis Steiner by A. L. Taylor[1].

Field #1, of 5 acres, has been planted alternately to field corn, sudan grass, and soybeans. According to the grower, poor growth, usually occurring in spots, has been noticed over the past 20 years. In 1956, the planting of field corn was a complete loss, and although the replanted corn made better growth, the crop did not mature. This field has soil that can be described as a loamy sand, and is underlaid with clay at an average depth of 18 inches.

Poor growth in field #2, located about 100 yards from field #1, was noticed for the first time in the 1956 planting of field corn. A spot of about 1/4 acre, on the edge of the field facing field #1, was affected. Previous crops include field corn, alfalfa, and pasture grasses.

Previously published records of Belonolaimus have indicated that this nematode did not occur north of Virginia, except for one occurrence in a greenhouse in Connecticut[2].

The question of how the infestation originated is still unanswered. No possible contact between the Southern States at this farm could be recalled, beyond the planting of tomatoes about 15 years ago; the plants for which could have come from the South. No tomatoes or other set plants have been planted since that time.

In any event, it is interesting that Belonolaimus, a nematode adapted to a southerly climate, can maintain itself in New Jersey, particularly since the so-called "northern root-knot" nematode, Meloidogyne hapla, apparently cannot maintain itself too well over winter on strawberries in New Jersey although this plant is classified as a favorite host.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION, DEPARTMENT OF ENTOMOLOGY

[1] Section of Nematology, Horticultural Crops Research Branch, Agricultural Research Service, United States Department of Agriculture, Beltsville, Maryland.

[2] Holdeman, Q. L. 1955. The present known distribution of the sting nematode, Belonolaimus gracilis, in the coastal plain of the southeastern United States. Plant Dis. Reptr. 39: 5-8.

RELATIVE INCREASES OF POPULATIONS OF STING NEMATODE, BELONOLAIMUS GRACILIS, ON SIX WINTER LEGUMES

J. M. Good and G. D. Thornton[1]

ABSTRACT

In greenhouse pot studies, the relative increases of populations of Belonolaimus gracilis Steiner, 1949, on six winter legumes were determined. In 10 weeks significant increases occurred in sting nematode populations maintained on hairy vetch (Vicia villosa) and Dixie crimson clover (Trifolium incarnatum), but the population decreased slightly on bitter blue lupine (Lupinus angustifolius). Significant differences in sting nematode populations did not occur on Hubam sweetclover (Melilotus alba), sweet yellow lupine (Lupinus luteus), or Austrian winter pea (Pisum sativum); although the populations tended to remain small on all three.

Although quantitative information as to the effect of common crop plants on populations of plant parasitic nematodes is of fundamental importance in planning crop rotation systems for nematode control, such information is available for only a few crop plants and nematode species. The work reported on in this paper was initiated to gather such quantitative information on the increase or decrease of populations of the sting nematode, Belonolaimus gracilis, Steiner, 1949, in the presence of six different winter legumes.

The sting nematode was first observed associated with the roots of corn at Sanford, Florida, and with roots of seedling slash and long leaf pines from nurseries in Florida (11). Since thenthe devastating behavior of this parasite on a number of crop plants has been established. The list of susceptible non-leguminous plants includes celery, millet, corn, cotton, pepper, squash, sorghum, onion, eggplant, okra, ragweed, cocklebur, and a number of grass species (1, 2, 3, 4, 8, 9). The known susceptible leguminous plants include snap and pole beans, soybean, cowpea, peanut, sesbania, and clover (1, 3, 7, 8, 10). Concerning the relative importance of cover crops, Brooks (1) observed that the increasing importance of sting nematode as a pathogen in recent years in southern Florida "coincides with a decrease in the use of velvet beans as a summer cover and an increase in the use of sesbania." Holdeman and Graham (9) have published the only report as to the relative susceptibility of various plants to sting nematodes. Using pot culture techniques, they demonstrated significant differences in sting nematode populations on a number of weeds and crop plants. In their tests sting nematode populations increased on all grasses but remained constant on ragweed and cocklebur.

On Jerusalem oak, horseweed, crotalaria, and peanut the populations decreased. Sting nematodes disappeared from pots containing crotalaria alone, but were able to maintain a sizeable population in pots where crabgrass and crotalaria were grown together.

MATERIALS AND METHODS

Only nematode-free soil was used: Arredondo fine sand was fumigated with a nematocide, D-D[2], in a 55-gallon oil drum; as the soil was placed in the drum each 1-foot layer received 3 cc of D-D per square foot; the drum was sealed for 10 days, and then the soil was spread on a greenhouse bench to aerate for 2 weeks. The soil in which the legumes were grown received the equivalent of 600 pounds per acre of calcium hydroxide and 600 pounds per acre of 0-12-20 fertilizer. Aristogold sweet corn (Zea mays) was used as a reference plant because of its known susceptibility to the sting nematode; soil in which it was grown received calcium hydroxide at a rate equivalent to 600 pounds per acre and 4-5-7 fertilizer at a rate equivalent to 1200 pounds per acre. Plants were grown in a greenhouse in 6-inch clay pots containing 1250 cc of soil.

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[2] A dichloropropene-dichloropropane mixture.

A randomized block design with 5 replications was used. The six legume test plants were Hubam sweetclover (Melilotus alba), sweet yellow lupine (Lupinus luteus), bitter blue lupine (Lupinus angustifolius), hairy vetch (Vicia villosa), Austrian winter pea (Pisum sativum), and Dixie crimson clover (Trifolium incarnatum). Seeds inoculated with appropriate species of Rhizobium were planted on January 22, 1954. Ten days later the plants were thinned to 3 per pot. Each pot was inoculated with 50 hand-picked sting nematodes. Because of difficulties in picking, inoculations were made on 2 days instead of 1: February 2 and 4, 1954. The nematodes were washed into a small hole in the soil centrally located between the 3 plants and then covered with soil. Beginning on April 13, 1954, the sting nematodes recovered from soil around the roots in each pot were counted under a stereoscopic microscope. One block a day was processed until all replications had been examined. Three separate counts of sting nematodes were made for each pot: a total of 21 nematode samples were examined each day. Each determination was made on a 150-cc soil sample which was processed by the Christie-Perry method (5), using a 100-mesh sieve to retain the nematodes. Nematodes obtained from the entire water content of the Baermann funnel were counted, for this procedure has been shown to reduce the variability normally present where counts are based on only a small quantity of water drawn from the funnel (6). The average number of nematodes per pot was calculated, and significance in populations between the test plants was determined by analysis of variance.

RESULTS AND DISCUSSION

Ten weeks after inoculation with sting nematodes significant differences in the numbers of nematodes in the samplings were detected (Table 1). Soil from the vetch, sweet corn, and Dixie crimson clover pots contained significantly larger numbers of sting nematodes than soil from bitter blue lupine pots. Vetch and Dixie crimson clover favored the development of sting nematodes more than bitter blue lupine, Hubam sweetclover, and sweet yellow lupine. Root observations indicated minor nematode injury to the root systems. Small brown lesions were noted on the roots of sweet yellow and bitter blue lupine.

Table 1. Sting nematodes recovered from 150 cc of soil, with reproduction rates on six winter legumes and on sweet corn 10 weeks after inoculation.

Test plants	Average number for five replications	Average reproduction rate for five replications
Bitter blue lupine	4.1	0.7
Hubam sweetclover	8.7	1.5
Sweet yellow lupine	10.0	1.7
Austrian winter pea	15.7	2.6
Dixie crimson clover	24.3	4.1
Aristogold sweet corn	48.7	8.1
Hairy vetch	55.4	9.2
Significance	**	**
L.S.D. .05	18.3	3.1

The initial inoculation was equivalent to 6 sting nematodes per 150 cc of soil in each pot. Dividing the average number of nematodes recovered from 150 cc of soil at the end of the experiment by 6 gives the multiplication or reproduction rate of sting nematode populations on the various crop plants (Table 1). A reproductive rate of 1.0 would indicate that the particular host maintained the original population. Assuming that most of the nematodes were recovered from the soil, bitter blue lupine failed to maintain the original population while all other plants increased the population. Sting nematode populations, or reproduction rates, increased slightly on Hubam sweetclover, sweet yellow lupine, and Austrian winter pea, and increased significantly on Dixie crimson clover, sweet corn, and vetch (Table 1).

The data presented here indicate the response of winter legumes and sweet corn to sting nematodes under greenhouse conditions. The actual increases in the field, however, would not

be expected to be so large as those exhibited here, but the relative increase should be about the same.

A winter cover crop that is resistant to or tolerant of plant nematodes is not absolutely necessary in the colder areas of the country because of the reduced activity of nematodes during the colder months. On the other hand, in areas of the Southeast that have mild winters, the selection of a susceptible winter cover crop can be a factor in sting nematode damage to spring and summer crops. On the basis of this experiment, hairy vetch, Dixie crimson clover, and possibly Austrian winter pea should not be planted in areas where sting nematodes are already established. Bitter blue lupine, which is relatively susceptible to rootknot nematodes (Meloidogyne spp.), conceivably will not contribute appreciably to the increase of sting nematode.

The senior author has observed severe sting nematode injury on several alfalfa varieties, not included in this experiment; large populations of this parasite were found in the soil surrounding plant roots, which showed root injury typical of sting nematode injury on other plants. Alfalfa, therefore, can probably be included in the list of crops that should not be grown when the sting nematode is present.

The experimental procedure outlined permits rapid screening of plants for future field trials since only a small expenditure of time and energy is required in comparison with preliminary field screening tests. It should be remembered that this type of experiment is not designed to find a plant that most easily succumbs to damage from a given nematode, but rather a plant that does not favor the reproduction and multiplication of that nematode. Severe injury to a test plant is not desirable, for a stunted plant is likely to have a reduced root system, and therefore fails to maintain the original population and gives an erroneous indication of nematode reproduction. Dead or severely injured plants are known to support smaller populations of plant parasitic nematodes than relatively healthy plants that have not begun to show severe symptoms of nematode infection. Accordingly, in tests designed to show the rate of increase of plant parasitic nematode populations, the nematode inoculum should be small, yet large enough to give statistically significant information at the termination of the experiment. In this experiment an inoculum of 50 sting nematodes fulfilled these requirements. Comparisons of the nematode susceptibility of plants grown at different times and by different workers under various conditions will be possible if a reference plant is included in experiments of this type. Sweet corn is an excellent reference plant for many field and vegetable crops because of its ease of culture and its susceptibility to many plant parasitic nematodes, such as Belonolaimus gracilis, Trichodorus spp., and Pratylenchus spp.

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DISEASES OF FORAGE CROPS IN NEW ENGLAND AND NEW YORK IN 1956[1]

R. A. Kilpatrick[2]

SUMMARY

A survey of diseases attacking forage crops in New England and New York was made at different times during the growing season of 1956. Primary attention was given Ladino white clover although observations were also made on other legumes and on grasses. At least two examinations were made of different fields throughout New England and one examination of fields in New York.

Surveys of diseases attacking forage crops in New England and New York were made June 4-8, June 25-27, July 26-27, September 5-7, and October 1-3, 1956. Inspections were made at Dover and Durham, New Hampshire, Kingston, Rhode Island, Storrs, Connecticut, Amherst, Massachusetts, Ithaca, New York, Burlington, Vermont, Orono and Presque Isle, Maine, and in farm fields of the respective States. Particular attention was given to leaf, stem, and stolon diseases of Ladino clover although in mixed stands grasses and other legumes were examined.

Seasonal conditions were quite unusual in 1956. The spring was wet and late, and frost came early in September. The humidity was high and temperatures were cool during June. July and August were somewhat dry at most places except at Presque Isle, Maine. The latter location was quite cool throughout the growing season. Temperatures were not so high as in 1955. A summary of the diseases found on the various crops follows:

LADINO CLOVER

Pepper spot (Pseudoplea trifolii) was the most common disease of Ladino clover in New England and New York. This disease was most prevalent in June in all States and in many areas caused heavy defoliation. Very susceptible plants were frequently defoliated resulting in bare stolons. Pepper spot was not seen at the Experimental Farm at Burlington, Vermont, although it was found 2 miles from the Station. No explanation can be given for its absence there in both June and September as the same white clover strains were found at Burlington as in other parts of New England and weather conditions were similar.

Stagonospora leaf spot (Stagonospora meliloti) was commonly found throughout the growing season at all locations in New England. In June, under high humidity and cool temperatures, severe injury was noted in plots at Durham, New Hampshire, and Orono, Maine. Spaced plants were heavily infected and in some cases 30 to 40 percent of the leaves were killed. As temperatures increased and humidity dropped, the amount of infection gradually decreased although the disease could be found in most all fields. Isolations from infected leaves yielded several different types of cultures of Stagonospora.

Curvularia leaf spot (Curvularia trifolii) was rarely found early in the growing season, but was observed in all States, particularly in July and September. At Durham, New Hampshire some plants showed heavy defoliation. The watersoaked lesions somewhat resembled bacterial leaf spot. In the field, the typical V-shaped lesion was apparent. Whenever the lesion occurred at the tip of the leaf curling of the tip resulted.

Cercospora leaf spot (Cercospora zebrina) was found in all States in most fields late in the growing season. It did not appear to be important in 1956.

Pseudopeziza leaf spot (Pseudopeziza trifolii) was most prevalent in Northern New Hampshire and Maine, although scattered infected plants were found in other States. This was the

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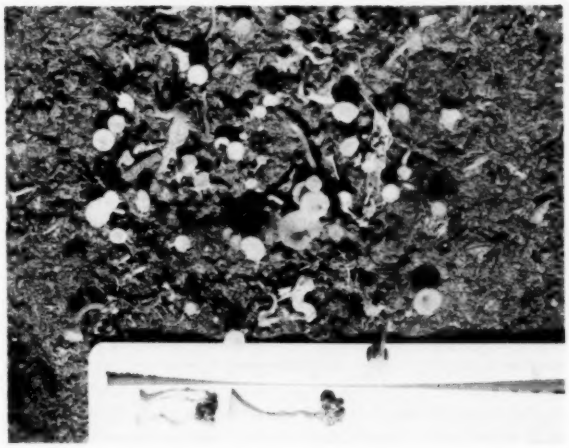

FIGURE 1. Apothecia of Sclerotinia trifoliorum found at Amherst, Massachusetts, October 2, 1956.

most common disease of white clovers in the vicinity of Presque Isle, Maine, in September.

Stemphylium leaf spot (Stemphylium sp.) was occasionally found in all States. It was not so prevalent in 1956 as in 1955.

Virus diseases (complex) were quite prevalent throughout New England and New York. The diseased condition was especially noted in June. During July and August the symptoms were less evident although scattered areas of infection could be found. Plants showing symptoms of the yellow patch virus were occasionally found in September and October in all States.

An unusual symptom affecting flowers was noted at Presque Isle, Maine in June. The flowers were transformed into vegetative organs and infected plants were stunted. Some flowers showed development of both unifoliate and trifoliate leaves. In other cases a new flower stalk had developed from individual flowers. The symptoms resembled a condition produced by the aster yellows virus. An examination of several strains of white clover indicated no difference in relative susceptibility. This unusual condition was found only in the Presque Isle area.

Sclerotinia stem rot (Sclerotinia trifoliorum) was commonly observed on Ladino in New England early in June, but not on this host in New York. The typical, water-soaked lesions were commonly found early in the growing season before the first cutting had been made. In most cases the white mycelial mat was easily observed on stolons and on many petioles. Later in the growing season stolons with the typical hollowed areas were found in many fields. On October 2 apothecia (Fig. 1) were abundant throughout plots of Ladino clover examined at Amherst, Massachusetts. At no other place in New England has the writer been able to find apothecia developing in the field.

Stolon rot (complex) was conspicuously absent in 1956 as compared with 1955. Late in the growing season it was observed in all States although it was most common at Durham, New Hampshire, and Amherst, Massachusetts. At Kingston, Rhode Island, attention was called to the fact that the discoloration nearly always occurred on the upper portion of the stolon. In cases of both light and moderate rotting the lower portion of the stolon was still green. Examination of plants with stolons beneath, and plants with stolons on, the soil surface indicated that aboveground stolons were more commonly affected. Apparently the condition is brought about by scalding or dessication. Isolations from this type of diseased tissue results in a complex of fungi, but primarily Fusarium oxysporum.

Sooty blotch (Cymadothea trifolii) and rusts (Uromyces trifolii trifolii-repentis) were commonly found late in the growing season. Rusts were particularly noticeable on plants growing under poor management. Neither disease appeared to be of importance in 1956.

RED CLOVER

Northern anthracnose (Kabatiella caulivora) was found at Dover, New Hampshire, Kingston, Rhode Island, different places in New York, and Presque Isle, Maine. The disease caused injury to many plants in southern New England and New York. In plots of red clover at Presque Isle, it had caused as much as 90 percent defoliation in several plots, which presented a

scorched appearance. The typical symptoms were found on petioles and stems. The new Wisconsin selection sustained defoliation estimated at 20 percent, the lowest injury among all strains planted, and in comparison with other strains it appeared promising from the standpoints of yield and disease resistance. In September the disease was still developing and leaf symptoms were noticeable, and differences between host strains were still striking.

Pseudopeziza leaf spot (Pseudopeziza trifolii) was commonly found around Presque Isle, Maine. In addition, it was found at Kingston, Rhode Island, Ithaca, New York, Dover, New Hampshire, and Orono, Maine. A spring seeding of red clover at Presque Isle showed heavy infection in September.

Stemphylium leaf spot (Stemphylium sarcinaeforme) was frequently found wherever red clover was growing. It was more prevalent late in the growing season than earlier, and was most prevalent in poorly managed fields.

Sooty blotch (Cymadothea trifolii), rust (Uromyces trifolii fallens), and powdery mildew (Erysiphe polygoni) were commonly found during the late summer in all States. These diseases were most conspicuous in fields left for seed and along roadsides. Rusts and powdery mildew cause some damage each year in the New England area.

Root and crown rot (complex) were commonly noted in June in New Hampshire and Rhode Island. Sclerotinia crown rot (Sclerotinia trifoliorum) was found in May at Dover, New Hampshire, where many plants were dead and others in the wilting stage. An examination of the roots showed the watery rot with numerous sclerotia near the roots. An occasional plant was found at Kingston, Rhode Island, in June with the wilting symptom and numerous dead petioles.

Viruses (complex) were occasionally found in New York, Rhode Island, New Hampshire, and Maine. The symptoms, as on white clovers, were most conspicuous in June. Older plants were severely stunted.

Cercospora leaf spot (Cercospora zebrina) was found in New Hampshire, Maine, New York, and Rhode Island. It was of minor importance in 1956.

ALSIKE CLOVER

Pseudopeziza leaf spot (Pseudopeziza trifolii) was severe on alsike clover in the vicinity of Presque Isle, Maine. Hardly a field could be found in which the leaf injury was not heavy. This was the primary disease on this host in New England.

Rust (Uromyces trifolii hybridi), powdery mildew (Erysiphe polygoni), and sooty blotch (Cymadothea trifolii) were frequently found on plants near roadsides. These diseases appear to be of importance only in areas of poor management.

Virus diseases (complex) were occasionally found although not abundantly. Infected plants were severely stunted.

ALFALFA

Common leaf spot (Pseudopeziza medicaginis) was the most common leaf disease of alfalfa in New England and New York. The disease caused premature defoliation in many areas.

Ascochyta leaf spot (Ascochyta imperfecta) was found in southern New England and New York but only rarely in northern New England. It was not so damaging as common leaf spot.

Virus infection (complex) was occasionally found in fields in Connecticut, New Hampshire, Maine, and Rhode Island. These diseases resulted in stunting, distortion, and, in general, plants were lacking in vigor and color.

Downy mildew (Peronospora sp.) was conspicuously absent in 1956. Only two infected fields were found. Plants in northern New Hampshire showed a considerable amount of chlorosis. A new spring seeding at Orono, Maine, was heavily infected. Approximately 50 percent of the plants had at least one leaf or more with the typical chlorosis and development of the conidiophores on the under surface of the leaves.

Plants exhibiting the typical symptoms of bacterial wilt (Corynebacterium insidiosum) were found in Rhode Island, Connecticut, and New Hampshire. A visual examination of the roots was made although positive identification was not confirmed.

Sclerotinia stem rot (Sclerotinia trifoliorum) was found in Rhode Island, Connecticut, Massachusetts, New York, and Vermont. The disease was found only in dense stands in June under high humidity. In each case the water-soaked areas were in advance of the mycelium on the stems. The sclerotia were occasionally found.

Stemphylium leaf spot (Stemphylium botryosum) was commonly found throughout New

England. The disease was less apparent in 1956 than in 1955, although some defoliation occurred in fields.

BROME GRASS

Brown spot (Pyrenophora bromi) is the number one disease of this host in New England and New York. It was more prevalent in northern than in southern New England and was more commonly found in June and July than in September. It caused defoliation in numerous areas.

Ergot (Claviceps purpurea) was commonly found in July and August at Dover, New Hampshire. The honey dew stage was prominent in fields in July, later the sclerotia protruding from individual spikelets were conspicuous. In one field in the northern part of New Hampshire Dr. Avery Rich observed a field in which approximately 25 percent of the spikes were infected. The disease was more prevalent in 1956 than in 1955.

Bacterial leaf spot (Pseudomonas coronafaciens var. atropurpurea) was observed in New Hampshire in June and July. This disease was most prevalent during cool moist weather, but was not of economic importance.

Powdery mildew (Erysiphe graminis) was observed in New Hampshire, New York, Rhode Island, and Connecticut. Only occasional plants were found with heavily infected leaves.

Rhynchosporium scald (Rhynchosporium secalis) was found on plants at Ithaca, New York, in June. In that area it was considered an important disease.

ORCHARD GRASS

Ergot (Claviceps purpurea) was found in New Hampshire on volunteer plants. The disease was of minor importance on the few affected plants seen.

Powdery mildew (Erysiphe graminis) was commonly found on plants in New York. In some areas it was causing injury to the lower leaves.

Sclerotinia crown rot (Sclerotinia trifoliorum) was found on plants at Amherst, Massachusetts. Crowns were frequently covered with the mycelial mat and outer stems showed typical watery, soft rot. In many instances apothecia were observed emerging from the mycelial mat. Numerous dead plants occurred throughout the plots. In areas with heavy nitrogen fertilization the injury was more apparent than in plots lower in nitrogen. Apparently the disease was causing a weakening of the plants and may be a contributing factor in winter killing. The injury appeared to be more extensive in plots on sandy loam than on plants growing in heavy clay soils.

OTHER PLANTS

TREFOIL: Stemphylium leaf spot (Stemphylium loti) was commonly found wherever trefoil was grown. It was noted at Kingston, Rhode Island, Dover, New Hampshire, Burlington, Vermont, and Orono, Maine. Although the disease was apparent in all fields defoliation was less than in 1955.

QUACK GRASS: Leaf smut (Ustilago striiformis) was found on volunteer plants at Amherst, Massachusetts, in June.

Powdery mildew (Erysiphe graminis) and rust (Puccinia sp.) were occasionally found on plants in New Hampshire.

TIMOTHY: Rust (Puccinia graminis) was frequently found in New Hampshire in July and August but was of minor importance.

Powdery mildew (Erysiphe graminis) was common on plants at Ithaca, New York. The disease was causing defoliation on many plants. Individual plant differences were noted.

BLUEGRASS: Rust (Puccinia rubigo-vera) was found on volunteer plants. Infected plants were heavily attacked and appeared to be causing some injury.

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NEW HOST RECORDS FOR DWARF BUNT IN THE PACIFIC NORTHWEST[1]

J. R. Hardison and J. P. Meiners[2]

Four species have been added to the list of grass hosts for dwarf bunt (Tilletia contraversa Kuehn) in the Pacific Northwest. These include two species of Elymus and one of Festuca. All infected plants of these new hosts were found in experimental plots on naturally infested soil in eastern Oregon or northern Idaho. E. canadensis L. (Canada wild-rye) plants were infected in both locations, while smutted plants of E. sibiricus L. (Siberian wild-rye) and Festuca elatior L. (meadow fescue) were found only in the Oregon planting. The infection of Elymus spp. by T. contraversa establishes a new host genus for this pathogen in North America. The only other record is that of a 1947 herbarium specimen originally identified as T. bornmulleri P. Magnus on E. crinitus Schreb., later identified as T. contraversa by Duran and Fischer (2). F. elatior is the second host species for dwarf bunt in the genus Festuca; infection of F. rubra L. was reported in 1954 (3).

Infected plants bore the characteristic symptoms of dwarf bunt. The shortened and broadened infected spikes of both of the Elymus spp. are shown in Figure 1. Infected culms of Festuca elatior were severely dwarfed, and size of panicles was greatly reduced (Figure 2).

Dwarf bunt also was found in 1956 in plants of Agropyron subsecundum (Link) Hitchc., A. trachycaulum (Link) Malte, and A. trichophorum (Link) Richt. in experimental plantings in eastern Oregon. Infection of A. subsecundum and A. trachycaulum had not been noted previously in Oregon.

In the experimental plantings in northern Idaho, dwarf bunt occurred on Tualatin oatgrass (Arrhenatherum elatius L.), mountain brome (Bromus marginatus Nees.) and Italian ryegrass (Lolium multiflorum Lam.). Previously the disease had been reported on A. elatius and B. marginatus only from eastern Oregon (4) and on L. multiflorum only from New York (1). A typical infected spike of L. multiflorum is shown in Figure 2.

In addition to the infections in the experimental plantings, dwarf bunt was found in a commercial field of intermediate wheatgrass (Agropyron intermedium (Host) Beauv.) near Rockford, Washington, within 10 miles of the Idaho grass nursery mentioned above. Apparently this represents the first known occurrence of dwarf bunt in a commercial grass planting outside of Oregon.

The 1955 report (6) of dwarf bunt in a natural stand of Bromus marginatus was confirmed in 1956 by a recurrence of the disease on this species in the same location. Malformation of spikelets and panicles in the 1956 specimens was more typical of other affected grasses than in those found in 1955, and, therefore, the smutted panicles were easily detected. Smutted plants of Agropyron trachycaulum also were found in this mixed stand of wild grasses, which was adjacent to a wheat field with a history of heavy dwarf bunt infestation.

In addition to the new host records for grasses, dwarf bunt was found on rye in Montana and Idaho for the first time. The disease has been reported previously on rye only from Utah (7) and Oregon (5). The infestation in Montana occurred in the Springhill locality near Bozeman and amounted to a trace to 1 percent infection in a 40-acre field. In Idaho, the disease was found near Tetonia on volunteer rye growing in a field of wheat. Both of these areas have long histories of dwarf bunt in wheat.

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[1] Cooperative investigations between the Field Crops Research Branch, Agricultural Research Service, United States Department of Agriculture and the Oregon, Washington, and Idaho Agricultural Experiment Stations.

[2] Pathologist, and Agent (Pathologist) respectively, Field Crops Research Branch, Agricultural Research Service, United States Department of Agriculture.

FIGURE 1. Healthy and dwarf bunt infested spikes of Elymus spp. Left to right: E. canadensis healthy, bunted; E. sibiricus healthy, bunted.

FIGURE 2. Healthy and dwarf bunt infested inflorescences of Festuca and Lolium. Left to right: F. elatior healthy, bunted; L. multiforum healthy, bunted.

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CEREAL RUST EPIDEMIOLOGY AND AEROBIOLOGY IN KANSAS IN 1956[1]

S. M. Pady and C. O. Johnston[2]

The development of two rusts of wheat (stem rust, Puccinia graminis Pers. f. sp. tritici Eriks. & E. Henn., and leaf rust, P. recondita Rob. ex Desm. (P. rubigo-vera f. sp. tritici)) and the concentration of the rust spores in the air were followed through the fall of 1955 and spring of 1956. Results of these studies are presented here.

In general, the amount of rust was much less in 1956, both in the air and in the field, than in previous years, and 1956 was one of the lightest, and at the same time, one of the most unusual leaf rust years experienced in the State. Not even in the dry 30's was so little rust recorded on wheat. On oats, stem rust was only a trace and crown rust was difficult to find.

During the fall of 1955, leaf rust and stem rust infections were almost nonexistent in the State, occurring as traces in volunteer wheat in the vicinity of Manhattan and in central Kansas. On a field trip in central Kansas October 18, 1955, 16 fields were examined and leaf rust was found but once and stem rust twice. During this period slides were exposed daily at Manhattan, and the data obtained are given in Table 1. Leaf rust spores were present as a trace on only 4 days during the period September 15 to October 28, while stem rust was present on about half of the days, but in low concentration. Although conditions were favorable for development of stem rust several times during this period, it was uncommon in fields in the State. No overwintering of either leaf or stem rust was observed or reported in the State in 1956.

In most years, development of cereal rusts in Texas and adjacent areas during the winter provides air-borne urediniospores and results in spore showers that produce infection as the growing season progresses. During the early spring of 1956 the development of rust followed an unusual pattern, owing to an unusual combination of circumstances. The drought continued in Texas and there was little rust inoculum available for northward distribution. Aside from two small pockets of infected wheat in northern Texas counties, the only stem rust infection of any consequence in Texas during May was in the lower Coastal Plain. Drought destroyed or severely damaged oats and wheat in central and northern Texas so that only traces of stem and crown rust were reported, although both rusts were abundant in southern Texas. All cereals were severely damaged by drought in Oklahoma and there was no buildup of rust in that State. Therefore, there was almost no inoculum that could be blown northward into Kansas.

The weather during April and the first week in May was cold and extremely dry in most of Kansas. A good rain of about an inch fell in some parts of the State April 29. After that date there was no general rain of any consequence until May 29, although a period of light showers occurred May 3 to 7, and another May 25 to 30. Temperatures were high during the second week of May, and combined heat and drought caused severe damage to cereals in the western two-thirds of the State.

Slides were set out daily, beginning April 18, 1956, and checked for the presence of leaf and stem rust spores (Fig. 1). Traces of stem rust spores occurred during several days in April and May. Although favorable infection conditions were present on April 28 and May 8, inoculum was extremely scarce. Owing principally to drought conditions, no rust of any kind could be found on cereals in Kansas during April and most of May. A single infection of stem rust in Pratt County May 23 was the first found in the State. On June 1, primary and some secondary infections of stem rust were found on wheat in central Kansas. These infections were widely scattered and difficult to find. Most primaries were large uredia on the leaves. In many cases small secondaries closely surrounded the large primaries. The primaries apparently developed after the rains of April 29. Thereafter lack of rainfall and development of high temperatures prevented a normal buildup of rust. After a shower period beginning May 3 and ending May 7, temperatures again rose, droughty conditions returned, and persisted until mid-June. Cereal rusts, therefore, encountered unfavorable conditions for their development. The only exception was in the area east of the Flint Hills from the Kansas River south to the Oklahoma line, where they were heavy rains and considerable stem rust developed in some fields.

The conditions unfavorable to leaf rust are reflected in the numbers of spores present on

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Table 1. Leaf rust and stem rust spores from 24-hour slide exposures September-October 1955, on a square foot basis.

Date	Number spores per square foot: Leaf rust	Stem rust	Wind	Temperature (°F): Max	Min	Precipitation (inches)
Sept. 15	-	-	S/SW	97	72	
16	-	T	S	98	75	
17, 18	-	710	S, NW	96, 94	73, 70	.06
19	-	-	NW/SE	89	68	-
20	-	T	SE	95	67	.29
21	-	T	V	92	61	.59
22	-	1065	SE	74	64	.53
23	T	710	SE	75	57	
24, 25	-	T	S, E	65, 56	53, 49	T, .81
26	-	T	SE/W/NW	64	49	.81
27	-	1420	W/SE	82	57	
28	-	1065	SE	81	46	T
29	T	710	NW	80	60	
30	-	1420	NW/NE	72	48	
Oct. 1, 2	T	T	SE	76, 77	44, 60	.40
3	-	-	SE	77	59	3.75
4	-	-	SE	76	59	.05
5	-	2485	SE/SW	82	67	
6	T	1065	SW/V/N	72	54	.27
7	-	-	W	69	43	
8, 9	-	-	S, SW	77, 79	41, 55	
10	-	-	S/SW	79	52	
Oct. 11	-	-	SW/N	85	58	
12	-	-	NW	76	49	
13	-	-	NW	70	37	
14	-	-	NW	66	36	
15, 16	-	4095	E	78, 66	31, 37	
17	-	-	N	64	35	
18	-	-	N	69	32	
19	-	710	S	81	35	
20	-	-	S	84	50	
21	-	-	NE	70	44	
22, 23	-	-	SE	81, 71	41, 41	
24	-	-	SW	65	27	
25	-	-	SW	78	34	
26	-	1065	S	84	31	
27	-	710	SW	79	52	.37
28	-	-	W/NW	71	41	

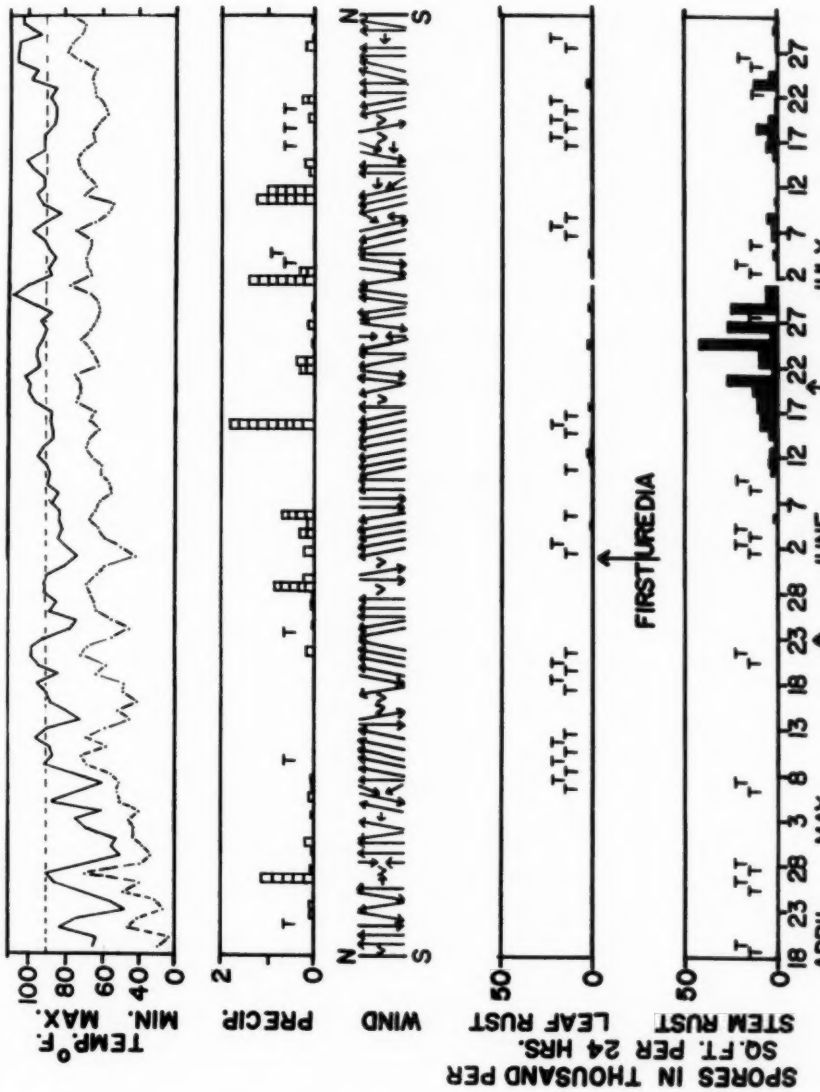

FIGURE 1. Summary of numbers of rust spores obtained on slides exposed on roof of Willard Hall, Kansas State College, with local meteorological data.

the slides (Fig. 1) compared with the two previous years[3, 4] when leaf rust spore showers reached peaks of 215,000 and 60,000 per square foot per 24 hours, respectively. There were many days when no leaf rust spores whatsoever were trapped during early June, when the numbers are normally the highest[3, 4]. The highest number recorded was 3,195 per square foot in 24 hours, June 25. Surveys made in the State during June indicated no leaf rust in the western third, traces in some of the fields in the central third, and traces in most fields in the eastern portion. In only a few fields in southeastern Kansas was leaf rust 100 percent prevalent by June 11 to 12. High temperatures from June 12 on caused the crop to ripen so rapidly that there was little green tissue left for the rust to grow on. This effectively checked the development of leaf rust. The year 1956 was definitely not a leaf rust year and prevalence of this rust was by far the lightest ever recorded.

Stem rust urediniospores again were at their peak about harvest time but numbers were much smaller than in 1954[3] and 1955[4]. During June stem rust was present as a trace in a few fields in western and central Kansas and in most fields in eastern Kansas. The low amount of inoculum in the air is in great contrast with that of 1954[3] and 1955[4] when spore showers reached peaks of 239,000 and 110,000 per square foot per 24 hours at harvest time. The maximum recorded in 1956 was 43,000 per square foot in 24 hours, June 25. This low spore number, combined with high temperatures in June, definitely curtailed the development of stem rust in the State.

The trace amounts of stem and leaf rusts of wheat in 1956 are probably the lowest that have been observed in recent years, and the losses were negligible. A strange feature of the rust picture this year was that stem rust appeared first in the State and in general was more widely distributed than leaf rust.

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TOXICITY OF MERCURIAL SEED DISINFECTANTS TO WHEAT[1]

C. H. Hsi[2]

ABSTRACT

A greenhouse experiment was conducted in 1955 to study the phytotoxicity of different mercury seed disinfectants applied at several dosages on two varieties of winter wheat.

Two criteria, stand reduction and number of normal seedlings, were used to measure phytotoxicity. Statistically significant differences in stand and in normal seedlings were obtained between: fungicidal treatments; dosages; dosages x varieties; dosages x fungicides; and dosages x varieties x fungicides. Significant differences in normal seedlings but non-significant differences in stand existed between: varieties; varieties x durations of storage; varieties x fungicides; and dosages x fungicides x durations of storage.

The results of this study suggest the need to consider both stand reduction and seedling injury in phytotoxicity studies. Seedling injury gave a more critical measure of phytotoxicity than did stand reduction in some cases. If only stand reduction had been considered, the differences in mercury injury exhibited by the two wheat varieties or phytotoxicity at the recommended dosages for commercial application would not have been revealed.

The results of this experiment substantiate previous findings that mercury injury to wheat is influenced by inherent differences in varieties, kind and dosage of fungicides, and duration of storage after treatment.

Panogen 15 was found to be least phytotoxic to wheat followed by Puratized Agricultural Spray, Agrox, and Ceresan M in that order. Ponca was more sensitive to mercury treatment than Cheyenne.

Phytotoxicity of mercury compounds to wheat has been reported by several workers in recent years. Purdy and Holton (5) in connection with their smut control work reported in 1954 that striking differences in phytotoxic properties occurred in overdosages from treating four wheat varieties with three mercury fungicides. At minimum dosages effective for smut control all materials were slightly, about equally, phytotoxic. At higher dosages, however, Panogen 15 consistently caused less reduction in stand than Agrox and Ceresan M. They also noticed that Marfed and Baart exhibited slightly greater tolerance to phytotoxic action of fungicides than Idaed and Federation.

In the same year, Koehler and Bever (3), on the basis of their results from experiments with wheat and oats, reported that damage to germination by volatile mercury compounds was increased with an increase in dosage, time, and grain moisture content. However, there were wide differences in fungicidal seed treating compounds with respect to the amount of damage. Such differences were not proportional to differences in volatility. For instance, the active ingredient in Panogen 21 was more volatile than that in Ceresan M, but the latter was more phytotoxic to wheat and oats.

Purdy (4) in 1955 concluded, from field and greenhouse tests, that there were no appreciable differences in phytotoxicity properties as exhibited by three mercury fungicides on seven varieties of winter and spring wheat. These results thus failed to substantiate those reported earlier by him (5) with respect to striking differences in phytotoxicity between the three mercury compounds at the overdosage level.

In general, most of the mercury fungicides now in use were considered to be relatively safe when used at recommended rates. However, Crosier and Midyette (2), after testing many treated commercial seed lots in the laboratory, found that abnormal germination typical of mercury poisoning was common in commercial seed lots treated with mercury compounds at recommended dosages.

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Table 1. Percent emergence and normal seedlings of two wheat varieties following treatment with 4 mercury seed disinfectants at 4 dosages and 2 storage periods.

Treatment	Rate	Sowing 2 days after treatment				Sowing 21 days after treatment			
		Cheyenne		Ponca		Cheyenne		Ponca	
		Stand	Normal Seedlings Stand		Normal Seedlings Stand		Normal Seedlings Stand		Normal Seedlings Stand
	oz./bu.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Check	H_2O only	66[a]	100[b]	87	100	54	100	79	100
Agrox	1/2	67	93	70	88	52	73	57	72
	2	10	40	9	25	10	50	10	7
	4	3	0	0	0	2	0	0	0
	8	0	0	0	0	0	0	0	0
Ceresan M	1/2	45	87	51	59	46	61	33	24
	2	9	0	37	14	7	0	10	38
	4	5	0	0	0	6	0	0	0
	8	0	0	0	0	0	0	0	0
Panogen 15	3/4	69	92	90	48	84	87	89	74
	2	32	78	61	49	33	57	68	54
	4	18	49	1	0	9	25	0	0
	8	0	0	0	0	0	0	0	0
Puratized Ag.Spray	3/4	61	81	74	49	69	83	73	73
	2	35	60	43	51	33	28	41	66
	4	10	32	0	0	6	0	0	0
	8	6	0	0	0	1	0	0	0

[a] Average of 2 replicates.

[b] Averageof 2 replicates. Percentage of normals out of germinating seedlings.

This report contains the results from greenhouse tests with mercury treatments of seed wheat. The experiment was conducted to secure the following information: 1) phytotoxicity of mercury compounds on winter wheat as measured by both reduction of seedling emergence and amount of seedling injury; 2) differential response of two genetically different varieties of winter wheat to the toxic effect of four mercury compounds as influenced by dosage and by duration of storage; 3) differential phytotoxicity exhibited by the mercury seed disinfectants to hard red winter wheat; and 4) differences in phytotoxicity due to interactions of variety, kind and dosage of mercury fungicides, and duration of storage after treatment.

Table 2. Analyses of variance for stand and for normal seedlings based on angular transformation of percentages to degrees.

Variation due to	Degrees of Freedom	Mean Squares	
		Stand	Normal Seedlings
Storages	1	93.85	12.92
Replicates	1	67.87	.23
Error (1)	1	91.12	40.17
Varieties	1	26.29	1086.36**
Fungicides	3	1283.50**	1622.32**
V x S	1	4.20	635.91**
F x S	3	34.22	59.32
V x F	3	57.64	517.44**
V x F x S	3	45.86	153.46
Error (2)	14	27.31	46.57
Dosages	3	18481.98**	23248.25**
D x S	3	3.78	59.82
D x V	3	749.42**	719.74**
D x F	9	320.91**	539.84**
D x V x S	3	34.43	82.37
D x F x S	9	46.10	223.20**
D x V x F	9	70.06*	325.93**
D x V x F x S	9	13.92	38.06
Error (3)	48	18.12	43.73
Total	127		

* Significant at 5% level.
** Significant at 1% level.

MATERIALS AND METHODS

Two varieties of hard red winter wheat, Cheyenne and Ponca, differing considerably in their genetic constitutions, were used. The four mercury seed disinfectants chosen as fungicidal seed treatments were:

Agrox -- 6.7% phenyl mercury urea
Ceresan M -- 7.7% ethyl mercury p-toluene sulfonanilide
Panogen 15 -- 2.2% methylmercury dicyandiamide
Puratized Agricultural Spray -- 7.5% phenyl mercuri triethanol ammonium lactate.

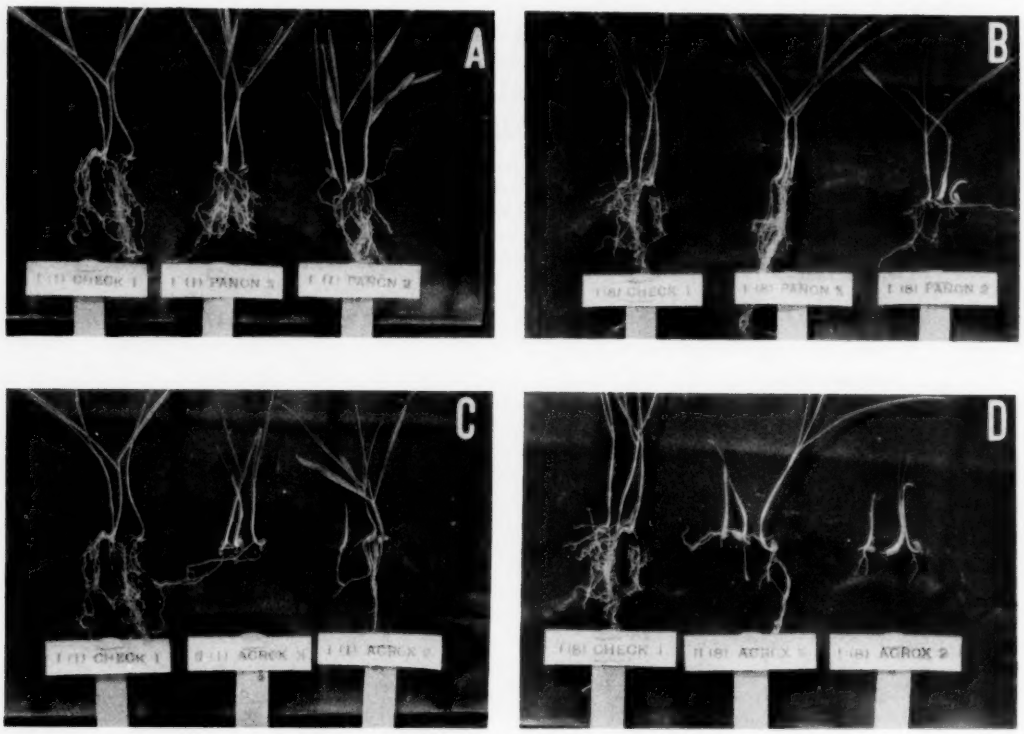

FIGURE 1. Mercury injury to wheat seedlings from treated seed. Normal seedlings to the left in each case. Panogen at 3/4 and 2 oz. per bushel -- A, Cheyenne wheat; B, Ponca. Agrox at 1/2 and 2 oz. -- C, Cheyenne; D, Ponca.

These four fungicides were chosen because they are highly effective in eradicating seed-borne wheat root rot inoculum.

All four mercury materials were applied to the seed of both varieties at four dosages ranging from 1/2 ounce (or 3/4 fluid ounce) to 8 ounces per bushel. The two dusts, Agrox and Ceresan M, were applied in slurry form, while two liquids, Panogen 15 and Puratized Agricultural Spray, were applied in dilute form. Three-ml water-suspensions of the different concentrations were applied to 42-ml lots of wheat seed in a large test tube. Each tube thus treated was closed promptly and tightly with a screw cap and was shaken vigorously until the suspension was distributed evenly on the seed. Agitation was repeated as necessary until the moisture was thoroughly absorbed by the seed.

All treated seed and water-treated checks were kept in the closed tubes in the laboratory at room temperatures. One planting was made in the greenhouse sand bench 2 full days after treatment, and another 21 days after treatment. Fifty seeds were planted in each row and each planting consisted of two replicates. The experimental design used was that of a split-plot, with replicates and durations of storage as main units, varieties and chemicals as the sub-units, and dosages as the smallest unit. Analysis of data expressed as percentages was made by transforming percentages to degrees as suggested by Bliss (1).

RESULTS AND DISCUSSION

Data on percentages of stand and of normal seedlings of the two wheat varieties treated at various dosages are summarized in Table 1. Table 2 combines the two separate analyses of variance for stand and for normal seedlings with the angular transformation of percentages to degrees.

Should stand reduction (Table 1) be used solely as the criterion to measure phytotoxicity, it would appear that mercury compounds caused little or no damage and in some cases even favored seed germination when they were applied at the commercially recommended rates. However, the percentages of normal seedlings in the same table reveal that all of the mercury compounds exerted some toxic effect on the germinating seedlings even when applied at the minimum dosages required for effective disease control. It was therefore concluded from these results that stand reduction alone was not sufficient to measure phytotoxicity and that both stand and normal seedlings should be considered in phytotoxicity studies with mercury fungicides.

No statistically significant differences in phytotoxicity existed between durations of storage after treatment or between replicates (Table 2). It should be pointed out, however, that the first planting of the treated seed was made 2 full days after treatment and that presumably some degree of phytotoxic action had occurred at that time. Should the seed be planted immediately after treatment, the results on phytotoxicity with respect to duration of storage probably would be quite different from those obtained. The second planting was made 21 days after treatment, and it would be entirely possible to obtain greater degrees of phytotoxicity from planting seed which was stored in the closed bottles for a longer period of time than from that stored for 21 days after treatment.

The close agreement between the results from the two replicates indicated the uniform conditions under which the experiment was conducted. In such cases more replicates apparently would not be necessary. In an experiment conducted purely for detecting biological significance, one replicate might be enough to demonstrate true differences. When subjecting experimental data to statistical analysis and for detecting possible variable conditions, two replicates are a minimum requirement for a scientific experiment.

No differences in stand reduction (Table 2), but significant differences in the amount of normal seedlings, were obtained between the two wheat varieties at the corresponding dosages of mercurial seed treatment. This is another reason why both stand reduction and number of normal seedlings need to be considered jointly in a phytotoxicity study. If the stand reduction alone is considered in this experiment, Ponca and Cheyenne exhibit about an equal amount of injury due to mercury treatments. However, when both criteria are used, Ponca appears to be much more sensitive to mercury treatments than Cheyenne.

Considering only the chemicals, differential phytotoxicity doubtlessly existed between the four mercury compounds as used on wheat in this experiment. Panogen 15 was least toxic to wheat, followed by Puratized Agricultural Spray, Agrox, and Ceresan M in that order. These differences in phytotoxicity, measured by stand and normal seedlings, were found statistically highly significant at the 1% level.

As expected, the degree of phytotoxicity increased in direct proportion to increasing rates of application. At 8 oz. per bushel, the stand reduction was complete except in two cases with Puratized Agricultural Spray on Cheyenne wheat.

With respect to the interactions, significant differences in stand reduction and in number of normal seedlings were obtained between: dosages x varieties; dosages x fungicides; and dosages x varieties x fungicides. Significant differences in normal seedlings but non-significant differences in stand existed between: varieties x durations of storage; varieties x fungicides; dosages x fungicdes x durations of storage. These results further indicate that phytotoxicity of mercury compounds to wheat is influenced by inherent differences in varieties, kind and dosage of fungicides, and duration of storage. The criterion of number of normal seedlings or injury to seedlings seemed to give a more critical measure of phytotoxicity than that of stand reduction in some cases. However, the most reliable results on phytotoxicity are derived from the joint consideration of the two criteria, stand and normal seedlings.

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SEED-TREATMENT TESTS ON SORGHUM IN 1956

R. W. Leukel[1], O. J. Webster[1], and R. W. Earhart[2]

Several mercurial fungicides failed to control covered-kernel smut in Rancher sorgo satisfactorily, in field experiments in 1955, even when applied at rates greater than those generally recommended. Fairly satisfactory control was obtained, however, with two non-mercurials, Phygon, applied at 3 and 4 ounces per bushel, and Orthocide, applied at 4 ounces per bushel.

In 1956 five of these mercurials along with two others were applied to separate lots of smut-infested seed of Rancher sorgo at rates of 2, 3, and 4 ounces per bushel. These rates were purely experimental and were used to determine whether covered kernel smut can be controlled in this variety, even at the cost of seed injury.

Table 1. Effect of seed-treatment with seven mercurial and two non-mercurial fungicides on emergence and on control of covered-kernel smut in Rancher sorgo, grown in field plots at Beltsville, Maryland, Lincoln, Nebraska, and Clemson, South Carolina in 1956.

Seed treatment				Emergence at			Percent smut at		
No.	Fungicide	form	oz/bu[a]	Beltsville	Lincoln	Clemson	Beltsville	Lincoln	Clemson
1	Ceresan M	sl	2	75	61	86	0	0	0
			3	76	56	75	0	0	0
			4	67	54	63	0	0	0
2	Ceresan D	l	2	75	69	89	0	0	0
			3	59	40	72	0	0	0
			4	55	34	19	0	0	0
3	Mema	l	2	77	55	62	0	0	0
			3	38	45	20	0	0	0
			4	35	29	42	0	0	0
4	Merculine	l	2	71	75	71	0	0	0
			3	66	60	33	0	0	0
			4	55	41	30	0	0	0
5	Panogen	l	2	77	71	84	0	0	0
			3	67	55	77	0	0	0
			4	69	48	56	0	0	0
6	Setrete	l	2	76	59	66	0	0	0
			3	47	56	38	0	0	0
			4	50	42	61	0	0	0
7	Memasol	sol	1/2	75	65	95	0	0	0
			3/4	79	55	96	0	0	0
			1	83	49	84	0	0	0
8	Phygon	sl	2	78	63	94	1.3	0	0
			3	82	67	87	2.0	0	0
			4	84	55	77	0.8	0	0
9	Orthocide	sl	2	84	56	96	1.1	0	0
			3	74	62	95	2.4	0	0
			4	81	63	85	1.7	0	0
10	Check		-	80	63	80	28	22	8

[a] The rates used are experimental and not recommended for farm use.

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Table 2. Emergence and control of covered-smut in Combine-60 Kafir, grown from smut-infested seed, treated as shown, and planted in field plots at 3 locations in 1956.

No.	Seed treatment: Fungicide	form	oz/bu [a]	Emergence (%) at: Beltsville [b]	Lincoln [c]	Percent smut at: Beltsville	Lincoln	Clemson
1	Ceresan M	sl	2	85	63	0	0	0
	Ceresan M	sl	3	84	57	0	0	0
2	Ceresan D	l	2	82	59	0	0	0
	Ceresan D	l	3	68	45	0	0	0
3	Mema	l	2	56	52	0	0	0
	Mema	l	3	50	42	0	0	0
4	Merculine	l	2	69	47	0	0	0
	Merculine	l	3	60	58	0	0	0
5	Panogen	l	2	90	71	0	0	0
	Panogen	l	3	77	60	0	0	0
6	Setrete	l	2	84	72	0	0	0
	Setrete	l	3	60	60	0	0	0
7	Memasol	sol	1/2	87	55	0	0	0
	Memasol	sol	3/4	95	58	0	0	0
8	Phygon	sl	3	88	67	0	0	0
	Phygon	sl	4	93	69	0	0	0
9	Orthocide	sl	3	92	49	0	0	0
	Orthocide	sl	4	90	52	0	0	0
10	Untreated	-	-	88	62	56	27	24

[a] These rates are not recommended for farm use.

[b] Greenhouse data.

[c] Field counts.

Portions of 500 cc (1/70 of a bushel) each of Rancher seed were placed in glass quart jars. The liquid mercurials, diluted 1 to 9 with water, were applied with a pipette at rates of 2, 3, and 4 ounces of chemical per bushel. Ceresan M was applied as a slurry at the same rates.

Memasol (YF 3576), a soluble powder, dissolved in water was applied at rates of 1/2, 3/4, and 1 ounce per bushel. Phygon and Orthocide were applied as slurries at 3, 4, and 5 ounces per bushel.

The treated seed, along with untreated seed as checks, was planted in field plots at Beltsville, Maryland, Lincoln, Nebraska, and Clemson, South Carolina. The data on emergence and smut control are presented in Table 1.

Smutty seed of Combine-60 kafir was treated with the same fungicides applied to Rancher sorgo, but only at the two lower rates. The untreated seed produced plants showing 56 percent infection at Beltsville, 27 percent at Lincoln, and 24 percent at Clemson. No smut appeared in any of the plants grown from treated seed, including those from seed treated at the lowest rate, 2 ounces per bushel (Table 2).

No explanation is offered for the unsatisfactory smut control in Rancher sorgo in 1955 at the 1.5 ounce-per-bushel rate of application of the six mercurials tested. Further tests are planned for 1957 to determine accurately the proper rate of treatment for controlling smut in this variety with these mercurials.

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SMUT CONTROL IN SORGHUM WITH THE ANTIBIOTIC COMPLEX F-17

R. W. Leukel and J. W. Mitchell[1]

Seeds of Rancher sorgo and Combine-60 kafir infested with spores of covered kernel smut (Sphacelotheca sorghi) were treated with an unpurified antibiotic mixture known as F-17. This mixture, obtained from a strain of Streptomyces by Pridham et al. (1, 2), was applied in three ways: (a) dry dust[2] on dry seeds; (b) dry dust on moist seeds; (c) 1-hour soak with seeds immersed in a dust suspension containing 4 gm dried of the solids per 250 cc of water for 1 hour.

The treated and untreated seeds were planted separately in 20-foot rows in a field at the Plant Industry Station, Beltsville, Maryland. Results observed after the plants had matured are shown in Table 1.

Table 1. Total and smutted heads of Rancher sorgo and Combine-60 kafir grown from untreated seeds, and seeds treated with F-17.

Treatment	Rancher heads			Combine 60 heads		
	Total	Smutted		Total	Smutted	
		No.	%		No.	%
None	190	73	38.4	180	90	50
Dry dust on dry seed	180	0	0	180	0	0
Dry dust on moist seed	175	2	1.1	180	0	0
1-hour soak of seeds in suspension	185	1	0.5	150	0	0

One purpose of this test was to determine the fungicidal or fungistatic properties of F-17 applied directly to the spores, prior to a study of its effect when applied to plants systemically infected with the organism. These preliminary results indicate, however, that a practical method of dusting seeds with F-17 for smut control could possibly be developed.

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THE USE OF ANTIBIOTICS AND FUNGICIDES IN MIST PROPAGATION[1]

R. E. Skiver[2]

SUMMARY

Carnation cuttings were rooted by means of a mist propagation system. The system provided for introduction of antibiotics and fungicides into the mist stream. The effects of the introduced chemicals on Alternaria blight and rust incited by Alternaria dianthi and Uromyces caryophyllinus respectively were studied.

Chemicals were first tested in the laboratory. Six of the most promising chemicals were tested under greenhouse conditions. The six chemicals (Captan, Tomatine, Omadine 1456, Omadine 1564, Omadine 1483, and Acti-dione) were used in separate experiments in which they were introduced into the mist stream and applied to 2 varieties of carnation cuttings while rooting. Acti-dione was eliminated because of its phytotoxic effects on cuttings.

The following results were obtained:

1) Captan, Tomatine, Omadine 1456, Omadine 1564, and Omadine 1483 significantly reduced the incidence of Alternaria blight.

2) Carnation rust appeared to be of little importance under the conditions of mist propagation encountered in these experiments.

3) Rooting was usually reduced in cuttings infected with A. dianthi.

4) Miller's Yellow variety tended to develop a better root system than Red Sim variety regardless of treatment when rooted under mist.

INTRODUCTION

Langhans (3) has reported the rooting of propagative material by spraying a fine mist intermittently over the surface of the material. Since the introduction of mist propagation, researchers and growers of greenhouse stock have shown considerable interest in the possibility of utilizing the method to grow better crops. Mist is now used extensively because cuttings root more quickly; also, a greater number root than when conventional methods are used.

This study was conducted to determine the importance of the potential threat of diseases under mist propagation and to investigate the possibilities of introducing antibiotics or fungicides into the mist stream as a means of controlling pathogens.

MATERIALS AND METHODS

Several antibiotics and fungicides were introduced into the mist stream, and their effect on Alternaria blight and carnation rust, incited by Alternaria dianthi Stev. & Hall, and Uromyces caryophyllinus (Schrank) Wint., respectively, was studied. The chemicals used are listed and identified in Table 1A, while concentrations of active materials and duration of application are shown in Table 1B.

All materials were first tested in the laboratory. Discs, 10 mm. in diameter, were cut from actively growing fungus cultures of A. dianthi[3] and placed with the fungal surface downward on potato-dextrose-agar plates containing the suspended chemical at various concentrations. Five plates were used for each concentration. Records of the radial growth were taken after 5 days. Six of the most promising materials (Acti-dione, Tomatine, Omadine 1456, Omadine 1483, Omadine 1564, and captan) were further tested successively in the greenhouse

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[3] Culture of A. dianthi supplied by Dr. Marlin Rogers, Cornell University.

Table 1A -- Materials tested in the laboratory, their chemical composition, and the name of the supplier.

Material	Chemical composition or name	Manufacturer or distributor
Actidione	3-[2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl]glutarimide	Upjohn and Company
Agrimycin 100	15% Streptomycin and 1½% oxytetracycline (4-dimethylamino-1,4,4a,5,5a,6,11,12a-octahydro-3,5,6,10,12,12a-hexahydroxy-6,methyl-1,11-dioxo-2-naphthacinecarboxamide)	Chas. Pfizer and Company
Captan	N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide	California Spray-Chemical Corp.
Experimental Quat B104	.....	Rohm and Haas Company
Omadine 1456	2-pyridinethione 1-oxide disulfide derivative	Olin Mathieson Chemical Corp.
Omadine 1483	Thio-urea derivative of pyridinethione	Olin Mathieson Chemical Corp.
Omadine 1564	2-pyridinethione 1-oxide, manganese salt	Olin Mathieson Chemical Corp.
Tomatine	.....	Drogaco, Industria Quimica
Zineb	zinc ethylenebis[dithiocarbamate]	Rohm and Haas Company

Table 1B -- Materials introduced into the mist stream of plots of Red Sim and Miller's Yellow carnation cuttings.

Chemical	Concentration of active ingredient	length of time applied
Captan	19 ppm	21 days
Actidione	2 ppm	21 days
Tomatine	2 ppm	21 days
Omadine 1456	10 ppm	7 days [a]
Omadine 1564	2 ppm	21 days
Omadine 1483	2 ppm	21 days

[a] Tap water applied for an additional 14 days.

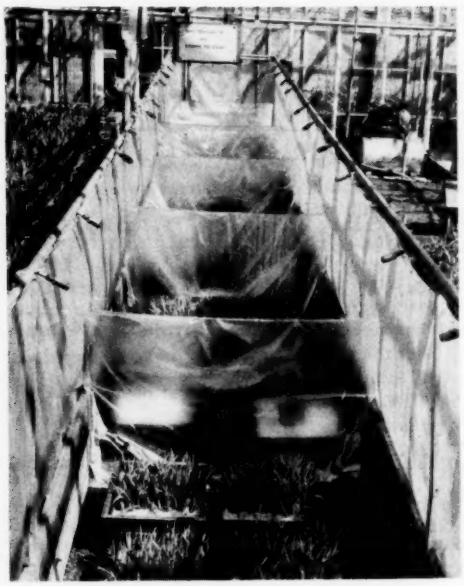

FIGURE 1. Mist propagative system showing nozzles, plots, and flats.

over a period of 2 years as described below. Candicidin, while promising in laboratory tests, was not available in sufficient quantities for additional investigation.

A mist system patterned after that described by Langhans (3) was used. Two completely separate mist lines, each in the shape of a U, were suspended around the perimeter of the greenhouse bench. One system delivered tap water through evenly spaced nozzles to each of three alternate plots while the other system sprayed the three remaining plots with water containing a fungicide or an antibiotic. Plots were separated by plastic cloth dividers. The experimental arrangement is shown in Figure 1.

A 50-gallon drum for the storage of the fungicidal or antibiotic solution was placed under a greenhouse bench. The solution was then pumped from the drum by a shallow-well, reciprocating type pump into a pressure tank in which the water pressure ranged between 35 to 55 psi. When a solenoid, which was operated by an interval timer (4 to 5 seconds "on", 55 to 56 seconds "off"), was opened, the solution flowed into one of the two lines to mist three of the plots while tap water from the second line sprayed the three remaining plots. The solution in the drum was renewed each day. The mist system was operative during the day only.

"Perlite", a commercial rooting medium, contained in redwood flats, served as a rooting medium for the cuttings.

Carnation cuttings of Red Sim and Miller's Yellow varieties 5 to 6 inches in length were taken from pathogen-free plants grown in increase blocks (7) and stored at a temperature of 38°-40° F for approximately 1 week. At the end of that time, the lower two leaves were stripped from the cuttings. The cuttings were dipped into a rooting hormone before planting or "striking" into the Perlite-containing flats. Using a vibrator type paint sprayer, a suspension of the appropriate pathogen[4] was sprayed on the "struck" cuttings. Inoculations were made the first evening after the mist system had been shut off for the night. Separate flats of uninoculated cuttings were placed in all plots to serve as controls.

At the end of a 21-day period, all cuttings were removed from the flats, washed, and rated both for severity of disease and amount of root formation.

Categories of incidence and severity of disease incited by Alternaria dianthi according to which each cutting was rated were as follows:

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[4] Uromyces caryophyllinus urediospores were from infected carnation leaves. Cultures of Alternaria dianthi were grown on potato-dextrose-agar. The agar and culture were mixed with 250 ml. of tap water in a Waring Blendor and the resultant suspension filtered through several layers of cheesecloth.

Table 2A -- Mean rooting indices[a, b] of two varieties of carnations inoculated with Alternaria dianthi and rooted under mist containing fungicides or antibiotics, as compared with cuttings sprayed with tap water.

Chemical	Red Sim				Miller's Yellow				Standard Error of Means
	Sprayed with Solution		Sprayed with Tap Water		Sprayed with Solution		Sprayed with Tap Water		
	Uninoculated	Inoculated	Uninoculated	Inoculated	Uninoculated	Inoculated	Uninoculated	Inoculated	
Captan	1.70	1.90	2.27	1.73	1.63	2.20	2.80	2.10	0.375
Tomatine	3.17	2.70	3.53	3.30	3.97	3.73	3.93	3.50	0.539
Omadine 1456	2.00	1.67	2.77	2.77	1.73	1.73	2.63	2.87	0.200
Omadine 1564	3.13	1.37	3.57	3.13	3.23	1.33	3.97	2.77	0.678
Omadine 1483	1.60	1.53	2.37	1.73	2.03	1.77	3.13	2.90	0.324

[a] Rooting index estimated visually on a 0-4 scale, with 0 = no roots, 4 = excellent rooting.

[b] Average values for 30 plants (3 replications, 10 plants per replication).

Table 2B -- Mean disease indices[a, b] of carnation cuttings inoculated with Alternaria dianthi and rooted under mist containing fungicides or antibiotics as compared with cuttings sprayed with tap water.

Chemical	Red Sim		Miller's Yellow		Standard Error of Means
	Sprayed with Solution	Sprayed with Tap Water	Sprayed with Solution	Sprayed with Tap Water	
Captan	1.23	3.13	1.03	2.87	0.243
Tomatine	1.37	2.13	1.53	2.50	0.360
Omadine 1456	0.50	2.93	0.37	3.03	0.264
Omadine 1564	1.37	3.17	1.33	2.80	0.274
Omadine 1483	0.13	0.90	0.03	0.97	0.264

Disease index of uninoculated control was zero.

[a] Disease index estimated visually on a 0-5 scale, with 0 = no leaf spotting, 5 = girdling of stems.

[b] Average values for 30 plants (3 replications, 10 plants per replication).

Table 3A -- Analyses of variance of root indices of cuttings[a] inoculated with Alternaria dianthi and rooted under mist containing fungicides or antibiotics as compared with cuttings misted with tap water. Red Sim and Miller's Yellow varieties of carnations.

	D. F.	Mean square				
		Captan	Tomatine	Omadine 1456	Omadine 1564	Omadine 1483
Mist Treatment	1	0.08*	0.18	5.70**	7.15**	3.86**
Varieties	1	0.48	2.22*	0.02	0.00	2.55**
T x V	1	0.17	0.42	0.01	0.00	0.58*
Disease	1	0.08	0.70	0.00	10.54**	0.56*
T x D	1	1.50**	0.01	0.00	1.54	0.00
V x D	1	0.02	0.00	0.12	0.30	0.08
T x V x D	1	0.34	1.21*	0.13	0.17	0.16
Error	16	0.141	0.290	0.400	0.460	0.105

* Significance at 5 percent level.
** Significance at 1 percent level.
[a] Red Sim and Miller's Yellow varieties.

Table 3B -- Analyses of variance of disease indices between Red Sim and Miller's Yellow varieties of carnations inoculated with Alternaria dianthi and treated with mist containing fungicides or antibiotics.

	D.F.	Mean Square				
		Captan	Tomatine	Omadine 1456	Omadine 1564	Omadine 1483
Mist Treatment	1	10.45*	2.26**	19.43**	8.01**	2.17**
Varieties	1	0.17	0.22	0.00	0.12	0.00
T x V	1	0.00	0.02	0.12	0.08	0.02
Error	8	0.059	0.130	0.070	0.075	0.070

* Significance at 5 percent level.
** Significance at 1 percent level.

Class 0 -- No leaf spotting.
Class 1 -- A few, small spots on leaves.
Class 2 -- Numerous small spots on leaves.
Class 3 -- Numerous large spots on leaves and lesions at tips of leaves surrounding apical regions.
Class 4 -- Stem lesions.
Class 5 -- Complete girdling of plant.

The amount of root formation was rated according to the following system:

Class 0 -- No evidence of root initiation or proliferation of tissues at the base of the cutting.
Class 1 -- Marked proliferation of tissues at the base of the cutting with some roots initiated.
Class 2 -- Root system comparatively well formed.
Class 3 -- Root system well formed.
Class 4 -- Excellent root formation with longer roots than in previous class; 3/4 inch or longer.

Cuttings which had been inoculated with the rust pathogen were transferred to flats containing soil and observations of pustule development were continued for an additional 3- to 4-week period.

RESULTS

The collected data (summarized in Tables 2A, 2B, 3A, 3B), derived from tests involving Alternaria blight in which fungicides or antibiotics were introduced into the mist system, were analyzed statistically by an analysis of variance. Comparative analyses were made to determine the influence of the disease on the two carnation varieties used in the tests, the comparative rooting of each variety, and the effect of each fungicidal or antibiotic treatment on rooting and disease development.

Of the six chemicals tested in the greenhouse, the effects of all except Acti-dione were analyzed. No analysis of the latter was made because of the toxicity of this material to carnation stem tissue. A collapse of tissue was noted in that part of the cutting which was buried in the rooting medium.

Each of the five chemicals tested reduced significantly (1% level) the incidence of Alternaria blight (Table 3B). There was no difference in disease reduction between varieties. No consistent differences in susceptibility of either variety were noted.

Mist treatment with antibiotics or fungicides (Table 3A) reduced rooting in every case except one in which uninoculated Miller's Yellow cuttings sprayed with a solution containing Tomatine rooted as well as those sprayed with water alone. The reduction was highly significant (1% level) using Omadine 1483, Omadine 1564, and Omadine 1456, and significant (5% level) using captan.

Without regard to chemical, there was no consistent difference in rooting between carnation varieties after inoculation. There was a reduction in rooting of inoculated cuttings as compared with uninoculated controls. This general trend attained significance in experiments in which Omadine 1483 (5% level) and Omadine 1564 (1% level) were tested. However, comparisons between uninoculated cuttings of both carnation varieties showed that Miller's Yellow cuttings developed a better root system than the Red Sim variety. This varietal difference reached significance only in tests using Omadine 1483 (1% level) and Tomatine (5% level).

Under conditions of the experiments in this study, virtually no rust development was discernible on inoculated cuttings in any plot except during the month of March, 1956, when one or two small pustules were noted on several plants in all plots. Cuttings transferred to flats for additional observation did not develop new lesions.

DISCUSSION

The introduction of antibiotics or fungicides into the water of a mist propagative system shows promise as a means of controlling carnation diseases. In the present experiments, incidence of Alternaria blight was significantly reduced, using captan, Tomatine, Omadine 1456, Omadine 1564, and Omadine 1483. Introduction of chemicals into the mist stream, however,

reduced rooting. This is an important consideration, because the purpose of this kind of propagative procedure is to provide a well-developed root system in a greater degree and more quickly than by conventional rooting practices.

The amount of rooting was always less in cuttings infected with Alternaria blight than in the respective non-inoculated controls. The fungus, by invading leaf or stem tissue, may influence elaboration and translocation of vital substances to the site of root formation.

No definite reason can be advanced for the nearly complete absence of rust during the course of the tests. A factor which has been proposed to account for non-establishment of the disease under mist is that spores are washed from leaves (3, 4, 5). This factor was not believed to be operative during the course of these experiments because rust urediospores were sprayed on the cuttings in the evening after the mist system had been turned off. Furthermore, tests involving Alternaria blight have indicated that that this disease develops whether inoculation occurs during the day under mist or at night when the system is not in operation (6).

Campbell and Dimock (1) reported that it was difficult to establish chrysanthemum rust (Puccinia chrysanthemi Roze) in greenhouses during summer months even when plants were incubated in low-temperature chambers for a brief period after inoculation. Their observations suggest that temperature is one of the more critical environmental factors associated with development of chrysanthemum rust. Further, Dimock and Baker (2) have demonstrated that two different temperatures are required for the development of epidemics of snapdragon rust (Puccinia antirrhini Diet. & Holw.), one temperature range being optimal for germination and infection and another for completion of the life cycle. While no critical work has been done in this regard with rust on carnation, temperatures under mist may not be conducive to development of the disease.

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SUSCEPTIBILITY OF SOME ORNAMENTAL AND VEGETABLE PLANTS TO STREPTOMYCIN INJURY[1]

Jack Altman and Stephen Bachelder

A phytotoxicity test with repeated applications of streptomycin was set up in March 1955 in the greenhouse to determine the relative tolerances of three ornamentals and three vegetables to streptomycin. Two of the vegetables were known to be fairly susceptible to streptomycin injury and one was known to be fairly tolerant. The ornamentals were of unknown tolerance.

MATERIALS AND METHODS

The plants included in the test were ivy (Hedera helix), geranium (Pelargonium hortorum), peperomia (P. crassifolia), bean (Phaseolus vulgaris var. Bountiful), sweet corn (Zea mays saccharata var. North Star), and pepper (Capsicum annuum var. California Wonder). The materials used in the sprays were: Streptomycin nitrate[2] at concentrations of 200, 400, 800, 1600, and 3200 ppm with and without 1% methyl cellosolve (ethylene glycol monomethyl ether), a material reported by Goodman[3, 4] to increase the effectiveness of streptomycin. Triton B-1956 at 2 ounces per 100 gallons was added to all sprays. Spray applications were made on March 16, 22, 29, April 1 and 11, 1955.

RESULTS

Observations were made one week following each application. The results are given in Table 1.

DISCUSSION

Applications of streptomycin sprays on greenhouse-grown ornamental and vegetable plants produced varying degrees of injury depending on kind of plant, concentration of streptomycin, presence of a cuticle penetrant, and number of applications. The injury noted on affected plants was manifested as a bleaching effect or the appearance of yellow patches on the leaves. On corn, however, at concentrations of 800 to 3200 ppm, the bleached areas became necrotic.

Ivy, peperomia, and pepper were very tolerant to single and successive spray applications, whereas geranium, corn, and bean were sensitive to the antibiotic at concentrations exceeding 400 ppm. Corn and bean showed moderate injury within one week after the first spray. This injury increased in severity with repeated applications and resulted in weakened and stunted plants. These necrotic areas on corn shrivelled and dried, resembling firing. On bean, the injury manifested itself in a mosaic type of yellowing or bleaching.

The slight injury noted on ivy appeared as a bleaching of the terminal leaves and some bleached apices of older leaves, whereas injury observed on peperomia appeared as a slight bleaching and stunting or curling of the apical leaves. On geranium, the injury occurred as bleached and chlorotic patches on the leaves. Bleaching often followed yellowing. Pepper was the most tolerant of the plants used. Slight injury appeared on peppers after the third spray application of streptomycin at 3200 ppm plus 1% methyl cellosolve. In all instances, the bleaching effect persisted for at least 2 months after the last spray was applied and, in the case of ivy, the bleached terminal leaves and the bleached apices of the older leaves were evident for 6 months after the sprays were applied. No water was applied to the foliage during the test. It is possible, therefore, that residues from successive spray applications remaining on the leaves during the entire test resulted in more severe injury than might have occurred under field conditions.

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[1] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Department of Plant Pathology, New Brunswick.

[2] "Phytomycin", supplied by E. R. Squibb and Sons.

[3] Goodman, R. N. 1954. Antibiotics for control of fireblight. Proc. Amer. Soc. Hort. Sci. 64: 186.

[4] Goodman, R. N. 1954. Development of methods for use of antibiotics to control fire blight. Univ. of Missouri Res. Bul. 540, 16 pp.

Table 1. Phytotoxicity of streptomycin[a] to three ornamentals and three vegetables one week after each of four applications.

Streptomycin Treatments	Ivy			Geranium			Peperomia			Corn			Bean			Pepper		
Application	A	B[b]	C[c]	A	B	C[d]	A	B	C	A	B	C	A	B	C	A	B	C
0 ppm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200 ppm	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
400 ppm	0	0	0	0	0	1	0	0	0	0	0	2	0	1	1	0	0	0
800 ppm	0	0	1	0	1	1	0	0	0	0	1	3	0	2	2	0	0	0
1600 ppm	0	1	1	1	2	3	0	0	0	1	2	3	1	3	3	0	0	0
3200 ppm	0	2	1	1	3	3	0	0	0	1	3	3	2	3	4	0	0	0
With 1% Methyl Cellosolve																		
0 ppm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200 ppm	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0
400 ppm	0	0	0	0	1	1	0	0	0	1	3	3	1	2	2	0	0	0
800 ppm	0	1	1	0	1	2	0	0	0	1	3	3	1	2	3	0	0	0
1600 ppm	0	1	1	1	3	3	0	1	1	2	4	4	2	3	3	0	0	0
3200 ppm	0	1	1	1	4	4	0	1	1	2	4	4	2	4	4	0	0	1

[a] A = after one spray application; B = after two spray applications; C = after three spray applications. 0 = no injury; 1 = slight bleaching; 2 = medium bleaching (spotty); 3 = severe bleaching; 4 = very severe bleaching and stunting. Results of four spray applications paralleled those of three applications.

[b] Young ivy leaves bleached when unfolded where injury is indicated.

[c] Apical leaves yellow, some apices on expanded leaves yellow.

[d] Stunting and curling of apical leaves.

The addition of 1% methyl cellosolve to the sprays resulted in increased injury. Since the methyl cellosolve caused no noticeable injury when used alone, it would appear that it resulted in increased absorption of streptomycin and thus more pronounced injury. Since streptomycin is relatively insoluble in fats and waxes, the thicker cuticle layers of ivy, peperomia, and pepper, the more tolerant plants, may have served as a barrier to streptomycin penetration and thus reduced the degree of injury.

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B-622 AS A CONTROL FOR GRAY LEAF SPOT OF TOMATO[1]

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Summary

In limited trials at two locations in Florida, B-622 (2, 4-dichloro-6-(O-chloro-anilino)-S-Triazine) gave outstanding control of Stemphylium solani Weber, the cause of gray leaf spot of tomato. No phytotoxicity was observed.

Gray leaf spot caused by Stemphylium solani Weber is one of the more serious diseases affecting the tomato in Florida. It is currently controlled by frequent and thorough application of carbamate fungicides (nabam plus zinc sulfate or manganese sulfate, zineb, or maneb)or the use of resistant varieties (Manalucie). One of the aims of the extensive program of fungicide testing in Florida is to develop better and cheaper controls for gray leaf spot and other diseases of the tomato. This article reports results of experiments in two locations in the State in which one fungicide gave outstanding control of gray leaf spot.

MATERIALS AND METHODS

The experiments were conducted at Ft. Pierce in the spring of 1955 and at Homestead during the winter of 1955-56. In both cases, tests were conducted in the field and treatments were randomized in four replicates. Plots at Ft. Pierce consisted of 34 plants set in two rows; at Homestead plots contained 30 plants in a single row. The Homestead variety, which is susceptible to gray leaf spot, was used in each experiment. Further details of the experiments are discussed separately.

Ft. Pierce Experiment: -- This test was in the nature of a screening trial in which new or not too commonly used fungicides were tested. The materials used and concentrations are shown in Table 1. Seven applications at weekly intervals of the materials were made beginning March 16. Gray leaf spot appeared in the plots in early April, and within the 3-day period from April 18 through April 20 developed almost explosively, resulting in nearly complete defoliation of plants in some plots.

The plots were visually rated for disease control on April 21, using an arbitrary scale in which a value of 1 was assigned to plots showing excellent control (less than 5 percent defoliation) and a value of 10 (90 to 95 percent defoliation) assigned to check plots. The results obtained, Table 1, clearly showed B-622 (2, 4-dichloro-6-(O-chloroanilino)-S-Triazine) to be outstandingly superior to all other fungicides in this experiment. It was the only fungicide that gave excellent control.

Harvests were made on April 14, 26, and May 9. By the time of the second harvest, defoliation was so extensive in some plots that no differences existed between them and the check plots. However, the harvest at this date was of fruit already formed and matured before gray leaf spot became severe. The third and largest harvest on May 9 showed the devastating effects of the disease. Only the five best treatments and the check were harvested because the others were obviously no better than the check. Records on percentage of cull fruits, due largely to sunburn, are included because these reflect degree of defoliation.

The performance of B-622 was outstanding in this experiment whether considered on the basis of disease rating, yield, or percentage of culls.

Homestead Experiment: -- In this test B-622 was compared with (a) maneb and zineb on an alternating schedule (a program recommended for control of fungus diseases of tomato in Dade County, Florida), (b) a nabam plus copper sulfate plus zinc sulfate mixture, and (c) an untreated check. Nineteen applications were made on an approximate 5-day schedule between December 14 and February 3 after which applications were made three times a week until February 24. The increase in frequency of applications in February was necessary in order to control late blight (Phytophthora infestans (Mont.) DBy) which was extraordinarily severe during February. The plots were badly damaged by a freeze on January 15; as a result, production of fruit was so delayed that yield records were not taken.

[1] Florida Agricultural Experiment Station Journal Series, No. 534.

Table 1. Efficacy of various fungicides in the control of gray leaf spot of tomato, Ft. Pierce, Florida, 1955.

Treatment and amount per 100 gal.	Disease rating[a]	Yield in pounds per treatment: first two pickings	Yield in pounds per treatment: third picking only	Percent culls third harvest
B-622, 3 lbs. (Chemagro Corp.)	1.13	282	627	27.1
Crag 658, 2 lbs. (Carbide & Carbon)	3.00	340	532	38.5
Ferbam (76%) + ziram (76%), 1 lb. each	4.25	271	455	41.1
Tribasic Copper (50% Cu, 4% Zn), 4 lbs.	5.50	300	503	40.6
Captan (50%), 4 lbs.	5.63	294	467	35.8
Thiram (75%), 2 lbs.	6.50	298	-	-
Thioneb, 3/4 lb. (Naugatuck)	7.00	320	-	-
Cupron K-100, 1 lb. (Woudhuysen)	7.00	295	-	-
XSF #3, 1 qt. (Woudhuysen)	7.38	291	-	-
Dichlone (50%), 3/4 lb.	7.50	345	-	-
Terrachlor, 2 lbs. (Mathieson)	7.75	337	-	-
P-1122, 500 ppm.[b] (Gallowhur)	9.63	295	-	-
Check (no fungicide)	10.00	319	305	-
LSD (between treatment means) @ 5%	.88	NS	41	-
@ 1%	1.99	NS	NS	-

[a] 1 = excellent control (less than 5% defoliation); 10 = no control (90-95% defoliation).

[b] First application at 1000 ppm., subsequent applications at 500 ppm.

Table 2. Control of gray leaf spot and late blight of tomatoes with certain fungicides, Homestead, Florida, 1955-56.

Fungicide and amount per 100 gallons	Gray leaf spot index[a]	Late blight incidence[b]
Maneb (70%), 1.5 lbs. alternated with zineb (65%), 2 lbs.	13	1.5
Nabam (19%), 2 qts. + $CuSO_4$, 4 oz. + $ZnSO_4$, 9.6 oz.	12	7.8
B-622, 2 lbs. until Jan. 31, 3 lbs. thereafter	3	11.5
Check, no fungicide	61	50.8
L. S. D. at 5% level	7	10.2
L. S. D. at 1% level	10	14.1

[a] Figures are an approximation of the average number of lesions per leaflet.

[b] Average number of lesions on 10 leaves.

Gray leaf spot became severe in late January, developing particularly on the leaves which had survived the freeze. It was obvious upon casual inspection that the B-622-sprayed plots had less disease than the plots sprayed with other fungicides although all sprayed plots were much better than the check plots. On February 2 a 20-leaflet sample was obtained from each plot, the leaflets selected being picked at random from leaves which had escaped severe damage from the freeze. These leaflets were classified according to the number of lesions present and a disease index was calculated for each plot, the index value approximating the average number of lesions per leaflet. The results obtained, presented in Table 2, confirmed observations that B-622 gave control of gray leaf spot superior to that provided by recommended fungicides. It should be noted that this was accomplished at a dosage of 2 pounds per 100 gallons.

Late blight became very severe during early February but was variable in distribution among replicates. Within replicates, it was quite evident that location of a treatment materially influenced its performance. In view of these considerations, conclusions as to the relative effectiveness of B-622 for the control of late blight could not be made. After subsiding during the third week in February, the disease flared up again late in the month. Observations indicated that these infections were rather uniformly distributed over the test area. Incidence, determined on March 6 and presented in Table 2, shows that B-622 was effective in reducing late blight infections but was somewhat inferior to the recommended program of alternate applications of maneb and zineb.

DISCUSSION

Results of the experiments herein reported indicate that B-622 is quite effective as a control for gray leaf spot and suggest that it may not be quite so effective as maneb or zineb in controlling late blight of tomato. Unpublished results of experiments on certain other vegetable diseases suggest that B-622 may be somewhat specific under Florida conditions. It is apparent that much more work is needed, particularly concerning its effectiveness against other tomato diseases, before B-622 can be fully evaluated as a tomato fungicide for Florida.

It was reported previously[2] that B-622 had caused injury to tomatoes. No evidence of phytotoxicity was observed at either location in the present tests. The B-622 used in the 1952-53 test was submitted by a different company than the material used in the tests reported here. It is possible that the dissimilar results were due to differences in the formulations of B-622 used.

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[2] Conover, R. A., Florida Agr. Exp. Sta. Ann. Report for 1952-53, pp 323.

FORECASTING LATE BLIGHT OF POTATOES IN AROOSTOOK COUNTY, MAINE, IN 1956

R. A. Hyre and Reiner Bonde

ABSTRACT

Little late blight of potatoes, due to Phytophthora infestans, was present on the foliage in 1956. The estimated mean foliage blight was 2.5 percent. The rainfall-temperature method of forecasting blight was quite accurate when modified to allow for the unusually cool season.

INTRODUCTION

For the second successive year late blight was forecast in Aroostook County from rainfall and temperature data. The forecasts were designed primarily for the initial occurrence of blight in the commercial fields and blight was found in the southern and central parts of the county about when expected. It was not reported in the northern part of the county until a considerable time after it was expected. Also, the amount of blight at the end of the season was less than might have been expected. For these reasons a study was made of some of the weather factors involved and of the amount of blight present at the end of the season.

METHODS

The method used for forecasting late blight during the season was described recently by Hyre and Bonde[1]. Briefly, it is done from rainfall and temperature data supplied by United States Weather Bureau cooperators. Data are forwarded at 5-day intervals from Houlton, Presque Isle and Fort Kent. Temperature is considered favorable for blight if the 7-day mean is 77° F or less. Rainfall is considered favorable when the 10-day total equals 1.05 inches or more (1.20 inches was used the past two seasons). As a general rule blight is forecast after 10 consecutive days when both rainfall and temperature are favorable and the weather forecast at that time is for continued blight-favorable weather. The disease is expected one or two weeks after it is forecast.

A modification is proposed in the method as a result of the unusually cool season in 1956. At Presque Isle there were 26 days during June, July and August with a minimum temperature below 45° F. Crosier[2] (Fig. 10) has shown that the growth of Phytophthora infestans is slow at the lower temperatures, especially those below about 45°. By the modified method any day is considered unfavorable for blight if the minimum temperature falls below 45°. From hygrothermograph records it is seen that if the minimum temperature falls below 45° there usually are quite a few hours when the temperature is that low, or at least below 50° F.

For comparison blight-favorable periods were determined also from relative humidity and temperature data by locating a hygrothermograph in a shelter which was placed on sodded ground at Aroostook Farm. Periods were considered favorable for blight when the relative humidity was 90% or more and the temperature was either 45° to 53° F for 14 consecutive hours, 54°-59° for 12 hours, or 60°-77° for 10 hours.

In early September foliage blight in the county was estimated by the method of Horsfall and Barratt[3].

RESULTS

In Figure 1 are shown rainfall and temperature data from Houlton, Presque Isle, and Fort Kent, analyzed for forecasting late blight; the first reports of blight in commercial fields in the three areas; and blight-favorable periods at Presque Isle as determined from relative humidity-temperature data. In Table 1 is shown the amount of blight present in the county at

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[1] Hyre, R. A., and Reiner Bonde. 1955. Forecasting late blight of potato in northern Maine. Amer. Pot. Jour. 32: 119-125.

[2] Crosier, Willard. 1934. Studies in the biology of Phytophthora infestans (Mont.) de Bary. Cornell University Agr. Exp. Sta. Memoir 155: 1-40.

[3] Horsfall, J. G., and R. W. Barratt. 1945. An improved grading system for measuring plant diseases. (Abs.) Phytopath. 35: 655.

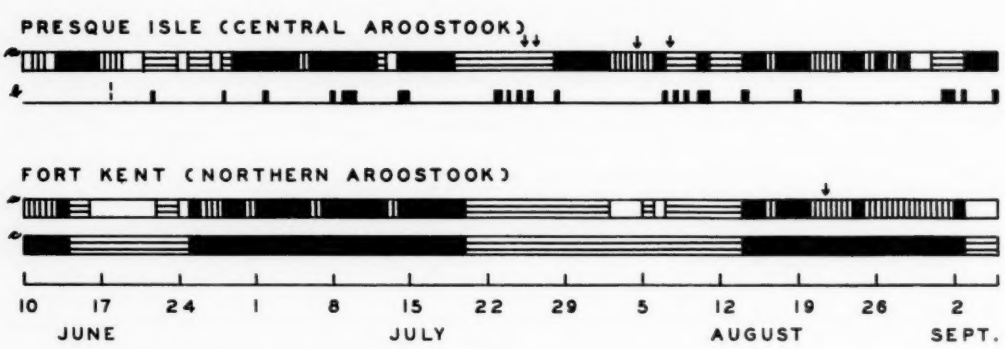
PRESQUE ISLE (CENTRAL AROOSTOOK)
FORT KENT (NORTHERN AROOSTOOK)
10 17 24 1 8 15 22 29 5 12 19 26 2
JUNE
JULY
AUGUST
SEPT.
~DAYS FAVORABLE FOR BLIGHT AS DETERMINED FROM RAINFALL AND TEMPERATURE DATA - RAINFALL FAVORABLE IF 10-DAY TOTAL IS 1.05 INCHES, OR MORE; TEMPERATURE FAVORABLE IF 7-DAY MEAN IS 77°F., OR LESS, EXCEPT ANY DAY IS UNFAVORABLE WITH A MINIMUM TEMPERATURE LESS THAN 45° F.
TEMPERATURE FAVORABLE
RAINFALL FAVORABLE
BOTH FAVORABLE
NEITHER FAVORABLE
†BLIGHT FAVORABLE PERIODS FROM HYGROTHERMOGRAPH CHARTS:
14 HOURS 45-53° F., RELATIVE HUMIDITY 90 PER CENT OR MORE.
12 " 54-59° F., " " " " " "
10 " 60-77° F., " " " " " "
~AS FOOTNOTE ~ EXCEPT MINIMUM TEMPERATURES BELOW 45° F. WERE DISREGARDED.
↓ EARLY OBSERVATIONS OF BLIGHT.

FIGURE 1. Analysis of weather data and the occurrence of late blight of potato in Aroostook County, Maine, in 1956.

Table 1. Extent of potato late blight infection in Aroostook County, Maine, as determined September 7 to 13, 1956.

Percent of late blight	Southern Aroostook		Central Aroostook		Northern Aroostook		Total	
	Number of Fields	Percent of Fields	Number of Fields	Percent of Fields	Number of Fields	Percent of Fields	Number of Fields	Percent of Fields
0	48	56.5	81	50.9	50	76.9	179	57.9
0-3	17	20.0	35	22.0	8	12.3	60	19.4
3-6	5	5.9	16	10.1	0	0	21	6.8
6-12	4	4.7	6	3.8	1	1.5	11	3.6
12-25	1	1.2	5	3.1	3	4.6	9	2.9
25-50	2	2.3	9	5.7	2	3.1	13	4.2
50-75	3	3.5	7	4.4	1	1.5	11	3.6
75-88	3	3.5	0	0	0	0	3	1.0
88-94	1	1.2	0	0	0	0	1	0.3
94-97	0	0	0	0	0	0	0	0
97-100	1	1.2	0	0	0	0	1	0.3
100	0	0	0	0	0	0	0	0
Total	85		159		65		309	
Mean % blight		3.0		3.0		0.6		2.5

the end of the season.

From the rainfall-temperature data blight would first be forecast in the three areas about July 10 to 12, when days with a minimum temperature less than 45° F are considered unfavorable for the disease. It actually was forecast about that time at Houlton and Presque Isle. It was forecast about 5 days earlier at Fort Kent when minimum temperatures were disregarded. The initial disease is expected about 7 to 14 days after first being forecast. It was first reported at Houlton on July 17 and at Presque Isle on July 25, about 6 and 14 days after being forecast. It was not reported in the Fort Kent area until August 21, about 40 days after being forecast.

The cool summer in 1956 is emphasized by the Fort Kent data. If minimum temperatures below 45° F were disregarded there were 48 blight-favorable days during the season. When days with a minimum temperature less than 45° were considered unfavorable for blight there were 28 favorable days during the season.

Less blight was expected in the Fort Kent area (along the St. John River) than elsewhere because 1) there were fewer blight-favorable days there than in the other two areas and 2) there was a 25-day period in midseason unfavorable for the disease. From Table 1 it is seen that this was true. There was 0.6 percent mean foliage blight at Fort Kent compared with 3.0 percent in the other two areas.

At Presque Isle blight favorable periods determined from relative humidity-temperature data indicated the disease might develop throughout the season, excepting possibly in late August.

Relatively little foliage blight occurred in Aroostook County in 1956. No blight was found in early September in about 50 percent of the fields in southern and central Aroostook County and in about 75 percent of the fields in the northern part of the county. Although an occasional field, or part of a field, was found that was well defoliated from late blight the mean blight was about 3 percent in the southern and central parts of the county and about 0.5 percent in the northern part.

The relatively small amount of blight in the county probably was partly due to the absence of early or universal infection of the cull piles. The authors found no late blight on 68 cull piles observed early in the season. Drs. E. S. Schultz and R. E. Webb found late blight on a cull pile on June 22 but not on 25 other cull piles examined. Also, of course, adequate spraying was very important in holding blight in check as evidenced by the fact that several small areas were completely blighted where spraying was inadequate or omitted.

Finally the modified forecasting method (days considered unfavorable for blight when the minimum temperature is less than 45° F) indicated there were very few periods after July 20 of sufficient length to favor the spread of blight. Thus, the system quite accurately reflected the amount of blight found at the end of the season; which amount was contrary to that intuitively expected.

HORTICULTURAL CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE; MAINE AGRICULTURAL EXPERIMENT STATION COOPERATING, ORONO

VERTICILLIOSE OF POTATOES IN PERU

C. Bazan de Segura[1]

When Abbot initiated the systematic scientific study of plant diseases in 1927, he found potatoes, both in the Sierras and on the coast, attacked by wilt, or drying disease, caused by Fusarium oxysporum. Later, Garcia Rada attributed serious losses in the Valley of Rimac, especially during the season of 1944, to the same disease.

Considering the heavy infestation of the soils of the Central Peruvian coast by Verticillium albo-atrum, which produces serious losses in cotton plantings there, it would be surprising if this fungus did not also attack potato particularly in view of the great increase in potato-growing in recent years.

During the present season, we visited potato fields in the Valley of Cañete at the invitation of the Director of the Experiment Station of Cañete. We observed serious abnormalities in potato root development there.

In a field on the Hacienda Cerro Alegre a high percentage of plants showed leaf symptoms similar to those presented by cotton plants attacked by V. albo-atrum, that is, brown scattered spots of variable size between the veins, dying and upward rolling of the leaves. Other symptoms were yellowing of the leaves, beginning with the lower ones which finally became dried out and died, many of them remaining hanging to the stems.

In longitudinal stem sections first a yellowing, later browning, was observed, especially in the vascular system. This discoloration appeared from the base to the tip of the plant, even extending into the petioles. In cross sections of the tubers also the same discoloration was encountered.

Different symptoms occurred in most of the other fields visited in Cañete, with up to 100 percent death of the plants. The symptoms were yellowing of the foliage, abundant formation of aerial tubers, erect terminal branches with the leaves completely rolled up, general drying out and premature death of the plants. Cuts made at the bases of the stems and in the tubers demonstrated symptoms of wilt (Fusarium or Verticillium); but in no case was stem rot (Rhizoctonia solani) noted.

Both types of disease were observed in potato fields in the Valley of Carabayllo this year although with much less intensity than in Cañete.

Verticillium albo-atrum was isolated in laboratory studies of the first group, that is the verticillíose symptoms, from both Cañete and Carabayllo, thus establishing for the first time that this fungus attacks potato under conditions prevailing in the central coast of Peru.

From the second group, that is diseased plants with aerial tubers from Cañete, two types of Fusarium were isolated. Moreover, plants with the same symptoms from Carabayllo yielded V. albo-atrum as well.

From these preliminary fungi studies we conclude that V. albo-atrum is attacking the potato crop in the central coast of Peru, not only alone but in combination with Fusarium spp. Alone, it produces symptoms similar to those produced in cotton; with Fusarium, it causes production of aerial tubers. Artificial inoculations are being continued in the laboratory with material from both localities.

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ANGULAR LEAF SPOT OF BEAN FOUND IN MARYLAND[1]

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Angular leaf spot of bean, caused by Isariopsis griseola Sacc., was found to be widespread in several large bean fields in Frederick County, Maryland, in 1956. This is the first report of its occurrence in the State since 1926, when F. P. McWhorter reported it in Allegany County. It was also found in Allegany County during the past season.

In early July, serious leaf infection by Isariopsis griseola was noted in a relatively large planting of Kinghorn Wax bean near Frederick, Maryland. No pod infection was observed. The canner who harvested this crop estimated a 20 percent reduction in yield due to the disease in the second and later pickings.

In later plantings a heavy infection also appeared on both primary and trifoliate leaves of several varieties, causing considerable defoliation and a reduction in yield. The causal fungus was so widely disseminated that almost 100 percent of the plants were seriously infected. Infection was noted on mature pods.

In addition to Kinghorn Wax, the varieties Tenderbest, Pearlgreen, Kingreen, and Processor and a green-seeded variety, Cheveret, were susceptible. Kinghorn Wax and Cheveret appeared most susceptible. Little information is available regarding the susceptibility of American bean varieties to the fungus. In a recent greenhouse test at the Plant Industry Station, Beltsville, Maryland, U.I. Pinto No. 111 appeared to be tolerant of infection.

Since the disease has not been observed in Maryland for about 30 years, it is not known where the leaf spot infection originated. The Kinghorn Wax variety, on which infection was first noted, had been planted on land which had grown a crop of beans the previous year, but the disease was not observed in 1955 according to the grower. It is entirely possible, however, that the infection may have originated from the soil since the primary leaves of the plants of the 1956 crop were heavily infected.

The last report of the occurrence of the disease in the general area was in Pennsylvania in 1942. The writers have been informed that it was observed more recently in the mountain bean-growing section of Johnson County, Tennessee, and nearby areas in North Carolina.

From the 1956 observations, it is apparent that if the disease became widespread in Maryland in the future and occurred frequently, it could become a serious problem to Maryland bean growers. The junior writer observed this disease on beans in areas of Colombia, South America, where it sometimes causes almost complete defoliation within a few weeks after initial infection is noted.

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[1] Miscellaneous Publication No. 280, Contribution No. 2762 of the University of Maryland Agricultural Experiment Station, Department of Botany.

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POWDERY MILDEW RESISTANCE IN SOUTH CAROLINA CUCUMBERS

W. C. Barnes[1] and W. M. Epps[2]

Powdery mildew (Erysiphe cichoracearum) of cucumbers is seldom of any importance in the Southeastern States. Occasional centers of infection occur, usually late in the fall, and cause slight damage in small spots, but widespread and serious damage is rare.

In the past 5 years the authors have received numerous requests from many parts of the world for information concerning possible sources of resistance. Smith[3] reported resistance in Puerto Rico 37, but, unfortunately, the writers were unable to obtain adequate infection for a reliable rating of their breeding lines.

In the spring of 1955, a severe outbreak of powdery mildew developed in the Southern Cooperative Cucumber Variety Trials at the Virginia Truck Experiment Station, Norfolk, Virginia. The SC-50 lines were rated highly resistant; Ashley, Stono, and Palomar, moderately resistant; and Marketer highly susceptible to this disease.

In the spring of 1956, powdery mildew appeared on the Experiment Station farm near Charleston shortly after harvest began the last week of May. Before mid-June, production of marketable fruit on susceptible varieties had ceased because of the damage to the foliage. The varieties were rated on the 0-(immune) to 5-(highly susceptible) scale. The slicing varieties, Marketer, Long Marketer, and a breeding line entered as MR Cubit, received average ratings between 4.5 and 4.8. Model, Ohio MR17, and four breeding lines of pickles were also highly susceptible. In contrast, Ashley and Stono, 1956 downy mildew-resistant introductions from this station, rated 1.4 and 1.6 respectively, while several of the SC-50 series of breeding lines rated 1.0 or lower. Palomar, derived from a cross between the South Carolina introduction, Palmetto, and Marketer, was intermediate in resistance. Informal reports from Texas to Massachusetts, in 1956, indicated good field resistance in the South Carolina introductions, Palmetto, Santee, Ashley, and Stono, and very high resistance in SC-50.

Palmetto and Santee were derived from a cross of Puerto Rico 40 and Cubit; while Ashley and Stono are the result of crossing various breeding lines, all of which had Puerto Rico 40 in their ancestry. It is believed that resistance to powdery mildew was derived from this parent which was also the source of resistance to downy mildew. SC-50 was derived by backcrossing Ashley onto the F_1 of a P. I. 197087 x Ashley cross. The extremely high degree of resistance to powdery mildew in this breeding line was probably derived from both parents as P. I. 197087 also carries a high degree of resistance.

No information concerning the mode of inheritance of resistance to powdery mildew has been obtained, but Smith[3] reported it to be complex. In view of this, it seems surprising that all South Carolina introductions and numerous breeding lines now being carried possess such a high degree of resistance. Perhaps this is due to the practice of discarding any plant in the breeding program that defoliated prematurely, regardless of the cause. No doubt plants that were attacked late in the season by powdery mildew were thus eliminated, and the end result has been the development of lines all of which have acceptable resistance.

SC-50 is a slicing type cucumber that is genetically early and highly productive. The fruits are about 7 inches long in the market stage, very dark green in color and of fairly good shape. It carries a high degree of resistance to the common race of anthracnose (Colletotrichum lagenarium) and better resistance to downy mildew (Pseudoperonospora cubensis) than any variety currently available. Unfortunately, it is more susceptible to cold damage and gummy stem blight (Mycosphaerella melonis) than the varieties currently in use and therefore should not be introduced to the trade. In order that plant breeders throughout the world may have access to the excellent source of resistance to powdery mildew in SC-50, seed has been turned over to the Plant Introduction Section of the U. S. Department of Agriculture where it has been assigned the number P. I. 234517.

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[1] Superintendent, Clemson College Truck Experiment Station, Charleston, South Carolina.

[2] Head, Botany Department, Clemson Agricultural College, Clemson, South Carolina.

[3] Smith, Paul G. 1948. Powdery mildew resistance in cucumbers. Phytopathology 38: 1027-1028.

A WATERMELON PLANT WITH BROCCOLI TYPE OF INFLORESCENCES

P. A. Young

A teratological watermelon plant (Citrullus vulgaris) was found in a field of Black Diamond watermelons near Poyner, Texas on July 13, 1955. This plant had normal leaves and normal stems about 6 feet long, but no normal flowers nor fruits in this season when melons were being sold from the normal plants in this field. This abnormal plant bore many similar bunches of green sexless flowers (Figure 1). Each bunch had about 25 to 100 flowers some of which had flattened pedicels. The modified flower parts mostly resembled sepals. The peduncles grew long and thick with long hairs. The compact bunches of flowers were 1 to 6 inches in diameter depending on their ages.

FIGURE 1. One bunch of fasciated fleshy watermelon flowers photographed over a yardstick.

FIGURE 2. Leafy tendrils from stems of the watermelon plant with fasciated flowers.

The tendrils were mostly abnormal, greatly enlarged, partly white to yellow, and many of them bore green leaves on their tips (Figure 2).

The abnormal flowers and tendrils probably were due to a mutation as there was no indication of any disease or insect injury. However, only one plant showed the symptoms and it was sterile so there is no experimental evidence about the cause. Mutations may recur so it is useful to record the abnormalities of this plant.

TEXAS AGRICULTURAL EXPERIMENT STATION, TOMATO DISEASE LABORATORY, JACKSONVILLE, TEXAS

A MICRO SWITCH-ACTUATED LESION COUNTER FOR USE IN PLANT VIRUS STUDIES[1]

Clarence T. Lange and Paul R. Desjardins[2]

An electrical recording lesion counter has been constructed to tally the local lesions which appear on leaves after viral infection. This counter has a general construction similar to and the same function as one described by Wildman and Rappaport[3]. It does, however, have a different operating principle, and can be constructed for less than $20.00[4]. The continuing cost of battery replacement inherent in the counter described by Wildman and Rappaport has been eliminated in this design. Counters constructed according to their design can be modified with little effort.

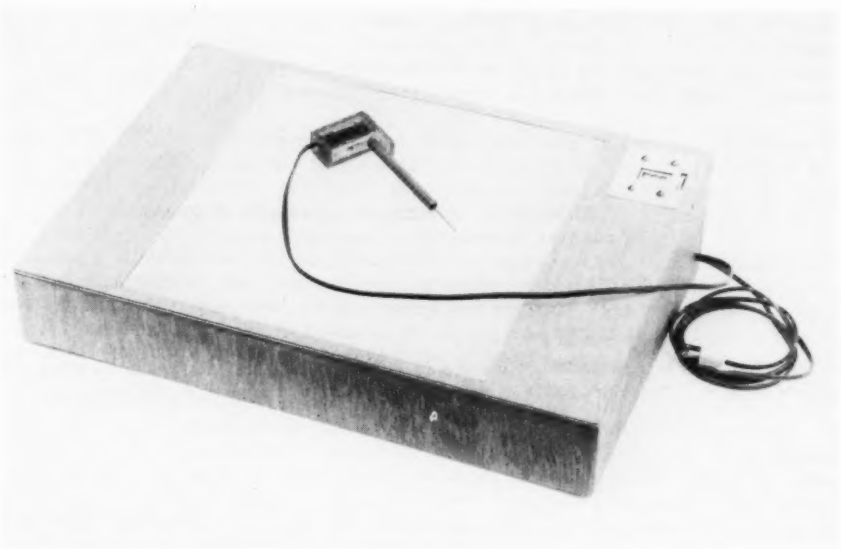

FIGURE 1. Lesion counter showing external arrangement.

The viewing portion of our counter (Fig. 1) is composed of a fluorescent illuminated light box with a 14-inch square frosted glass top. A magnetic recorder is panel mounted at the upper right corner of the top of the box. Lesions are counted by placing the infected leaf over the illuminated glass and puncturing the leaf at each lesion with the counting probe. The light showing through a leaf puncture indicates that the lesion has been counted. The counting probe is designed so that the pressure of marking a lesion with the probe actuates a

[1] This work was facilitated by Cancer Research Funds of the University of California.

[2] Senior Laboratory Technician and Assistant Plant Pathologist, respectively. Department of Plant Pathology, University of California, Citrus Experiment Station.

[3] Wildman, S. G., and Irving Rappaport. 1954. The use of electrically conducting glass for counting lesions. Science 119: 849-850.

[4] This price is based on the use of a three digit reset magnetic counter. Veeder-Root series 1507.

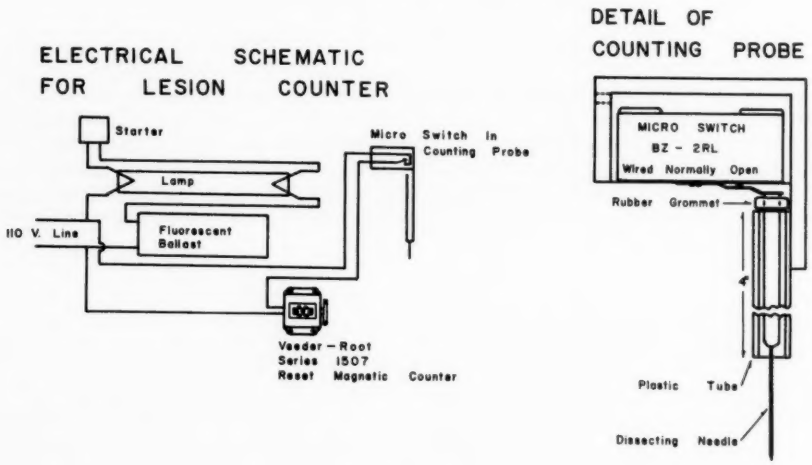

FIGURE 2. Electrical schematic diagram of counter, and detail of counting probe.

Micro Switch. The Micro Switch closes a 110-volt A. C. circuit thus activating the reset magnetic counter. The schematic diagram and detail of the probe are shown in Figure 2.

DEPARTMENT OF PLANT PATHOLOGY, CITRUS EXPERIMENT STATION, UNIVERSITY OF CALIFORNIA, RIVERSIDE, CALIFORNIA

A NATIONAL SURVEY STUDY OF THE SWEETPOTATO INTERNAL CORK DISEASE

E. M. Hildebrand, W. S. Anderson, and J. K. Ball[1]

In 1955-56 the United States Department of Agriculture directed a survey study on the incidence, severity, and extent of dissemination of sweetpotato internal cork virosis in the 1955 crop in 21 States. The study was conducted under a contract with the Mississippi Agricultural Experiment Station. W. S. Anderson and J. K. Ball were in charge of collection of root samples from the several States and their subsequent handling, including storage at 70° to 75° F to favor symptom expression in the roots, slicing the roots, scoring them for presence or lack of symptoms, and recording the findings.

During the summer of 1955 J. K. Ball visited all the States included in the survey, except California, to arrange with State staffs for collection of samples after harvest. The plan was to schedule collection of samples over about a 2-month period to coincide with the digging season in the respective States. In the autumn he returned to the cooperating States and hauled the samples to the storages in Mississippi. California samples were shipped to Mississippi by express. A total of 1075.5 bushels of samples was collected and stored. With a few exceptions the samples each measured about 1/2 bushel and contained about 50 roots.

The States and number of bushels received from each were as follows: Alabama 78; Arkansas 50; California 50; Delaware 2; Florida 7.5; Georgia 54; Illinois 15; Iowa 9.5; Kansas 25; Kentucky 16; Louisiana 89; Maryland 15.5; Mississippi 122.5; Missouri 27; New Jersey 42.5; North Carolina 29.5; Oklahoma 85.5; South Carolina 53.5; Tennessee 29.5; Texas 229; and Virginia 45.

It was planned to store the root samples under the most favorable conditions for inducing the necrotic spot symptoms. Arrangements were made for two storage houses in which the samples could be held at a temperature approximating 73° (70°-75°) F for a period of not less than 4 months. Incidentally, certain areas to be sampled were within the limits of Mississippi State sweetpotato quarantines, therefore one of the storage houses used was at the South Mississippi Branch Experiment Station in Poplarville, which was within weevil territory and where all samples from quarantine areas were stored. All the other samples were stored in a rented room of a large commercial storage house at Aberdeen near State College. Heat was supplied by electricity at Poplarville and by natural gas at Aberdeen. Temperatures were recorded by thermographs at both places and were satisfactorily maintained. Procedure was to start root slicing after approximately 5 months' storage, following a time sequence that would equalize the exposure period for all the samples. Slicing and scoring was begun on March 12, 1956 and completed on June 21. A semi-automatic meat slicer and an automatic vegetable slicer were employed. Each root was cut longitudinally into 1/8-inch slices collected on a tray, and all slices were examined for symptoms of internal cork. Each root was given one of four class designations and assigned an arbitrary numerical value somewhat proportional to the severity of economic impairment of the root for food, as follows:

Class 1: No cork symptoms -- Class value 0 (not illustrated).
Class 2: Slight symptoms -- Class value 2 (Fig. 1).
Class 3: Moderate symptoms-- Class value 3 (Fig. 2).
Class 4: Severe symptoms -- Class value 4 (Fig. 3).

The final evaluation for each sample was arrived at by calculating an average (per root) value from a total score figure for all the roots in the sample and the number of roots in the sample. This total score was calculated by summing up the products of the number of roots in each class times their respective score values and dividing by the number of roots in the sample. The resulting figure was the cork "score" value per root for each sample. Also calculated was the "percent" of the roots in the sample that showed cork symptoms.

[1] Plant Pathologist, Horticultural Crops Research Branch, Agricultural Research Service, United States Department of Agriculture, Plant Industry Station, Beltsville, Maryland; Head and Research Assistant, Department of Horticulture, Mississippi Agricultural Experiment Station, State College, Mississippi.

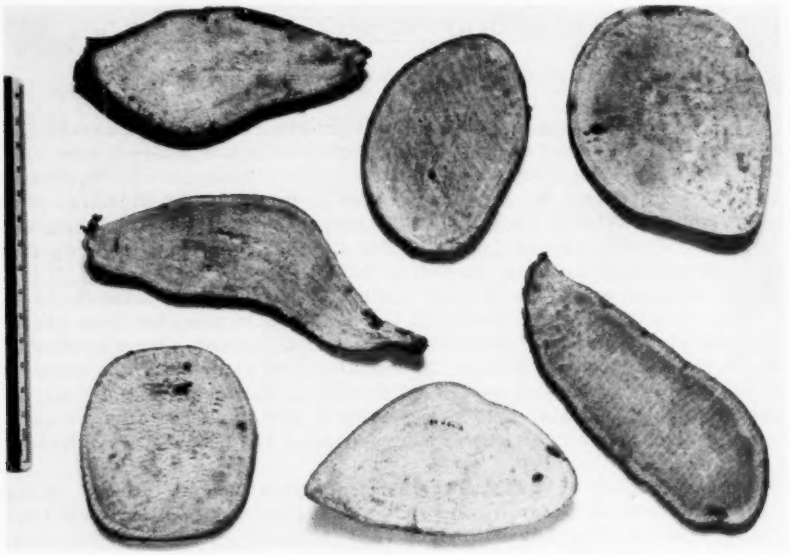

FIGURE 1. Slight symptoms of internal cork in Porto Rico sweetpotatoes with the lesions small, located near the surface, and involving less than 20 percent of the root.

FIGURE 2. Moderate symptoms of internal cork in Porto Rico sweetpotatoes (except slice in lower left hand corner which is severe) with the lesions somewhat larger, more widely distributed, but involving less than 50 percent of the root.

FIGURE 3. Severe symptoms of internal cork in Porto Rico sweetpotatoes with many lesions which are larger, generally distributed, and involving up to 100 percent of the root.

An example will now be given of the method used for calculating the results. A 49-root sample of the Porto Rico variety was sliced and found to exhibit symptoms as follows: Class 1, 12 roots; Class 2, 13 roots; Class 3, 10 roots; and Class 4, 14 roots. The calculations were made as follows: 0 x 12 = 0; 2 x 13 = 26; 5 x 10 = 50; and 10 x 14 = 140. Total = 216. 216 ÷ 49 = 4.32 score; 37 ÷ 49 = 75.5 percent cork.

RESULTS

Table 1 summarizes the results of the study by varieties and States. Under the "percent" heading in column 1 the samples were all placed in 6 percentage groups[2] ranging from 0 to 100 percent diseased, showing, namely: (1) 0, no cork; (2) 0-10 percent cork; (3) 10-25 percent cork; (4) 25-50 percent cork; (5) 50-75 percent cork; and (6) 75-100 percent cork. Under the "score" heading, the samples were placed in 6 score groups based on severity of symptoms, namely: (1) 0, no score; (2) 0-1.0 score; (3) 1.0-3.0 score; (4) 3.0-5.0 score; (5) 5.0-7.0 score; and (6) 7.0-10.0 score.

This study brings out clearly the prevalence and severity of internal cork symptoms in a number of well-known and new varieties of sweetpotatoes in 21 States. The Porto Rico variety was sampled in 19 States. The root symptoms were most severe in this variety in the Southeastern States, where the disease was first reported (Nusbaum, 1945)[3]. There were some cork-free samples of Porto Rico in most States that had cork-free samples of any variety. For the Porto Rico variety there were no cork-free samples from Delaware, Florida, Georgia, Kansas, Maryland, North Carolina, and South Carolina. Only in Arkansas were there more samples free from cork than diseased (18 and 17, respectively).

A study of Table 1 reveals many other interesting facts. Some varieties that exhibit foliage symptoms appear definitely resistant to disease expresion in the roots. To cite an

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[2] In Table 1 each "percent" and "score" group is recorded in round numbers for the sake of simplicity. However, in assembling the data in the table the first number of all the ranges starts 1 percent or 0.01 above that figure but ends in a round number.

[3] Nusbaum, C. J. 1945. A preliminary report on internal cork, a probable virus disease of sweetpotato. Plant Dis. Reporter 29: 677-678.

Table 1. Summary of results of national survey study on the incidence of internal cork virosis of sweetpotato varieties in 21 States during 1955-56.

	PORTO RICO																	GOLDRUSH									RED VELVET			
Internal Cork	Texas	Louisiana	Mississippi	Alabama	Georgia	South Carolina	North Carolina	Virginia	Maryland	Tennessee	Kentucky	Illinois	Arkansas	Missouri	Oklahoma	Kansas	California	Delaware	Florida	Missouri	Arkansas	Mississippi	Texas	Louisiana	Georgia	Maryland	Tennessee	Kentucky	Iowa	California	Arkansas	Texas	Kansas
Percent[a]																																
0	13	32	20	13	0	0	0	5	0	16	9	6	18	3	6	0	14	0	0	1	7	0	1	2	0	1	0	1	0	9	3	3	0
0-10	10	33	26	10	1	3	0	6	1	4	8	4	3	3	3	0	24	0	1	3	2	6	0	1	1	1	0	0	0	5	1	2	0
10-25	13	22	16	7	9	10	0	5	0	5	4	4	3	4	6	1	10	0	1	0	1	2	0	0	0	0	0	0	1	3	2	0	0
25-50	41	41	37	15	14	16	1	20	3	8	2	4	3	5	8	1	4	1	2	4	0	1	3	0	0	1	1	0	0	0	0	0	1
50-75	45	29	57	27	28	28	6	28	2	6	4	0	7	0	8	1	3	2	3	4	0	0	2	0	2	0	0	0	0	1	0	0	0
75-100	134	18	64	83	34	50	21	15	3	8	5	1	1	1	8	3	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Score[b]																																
0	13	32	20	13	0	0	0	5	0	16	9	6	18	3	6	0	14	0	0	1	7	0	1	2	0	1	0	1	0	9	3	3	0
0-1.0	20	40	31	13	7	9	0	10	1	8	13	6	3	5	6	0	29	0	1	3	2	7	0	1	1	1	0	0	1	8	2	2	0
1.0-3.0	36	47	38	17	19	20	2	26	4	6	2	4	6	6	10	1	6	1	1	4	1	1	1	0	0	1	1	0	0	1	1	0	1
3.0-5.0	48	31	46	24	18	30	4	25	3	9	2	2	6	1	8	2	2	2	4	2	0	0	4	0	1	0	0	0	0	0	0	0	0
5.0-7.0	59	19	58	35	31	33	11	13	1	6	6	1	2	0	4	1	4	2	3	2	0	1	0	0	1	0	0	0	0	0	0	0	0
7.0-10.0	80	6	27	53	11	13	11	0	0	2	0	0	0	1	5	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ratio -/+[c]	13/243	32/143	20/200	13/142	0/86	0/107	0/28	5/74	0/9	16/31	9/23	6/13	18/17	3/13	6/33	0/6	14/41	0/5	0/14	1/11	7/3	0/9	1/5	2/1	0/3	1/2	0/1	1/0	0/1	9/9	3/3	2/1	0
Total Samples	256	175	220	155	86	107	28	79	9	47	32	19	35	16	39	6	55	5	14	12	10	9	6	3	3	3	1	1	1	18	6	5	1

	ALLGOLD							RED GOLD		NEMAGOLD				JERSEY ORANGE				YELLOW JERSEY			KAN-DEE		NANCY HALL (2)	GOLD (14)			RED NANCY		ORLIS		SUNNY-SIDE		EARLY-PORT
Internal Cork	Oklahoma	Arkansas	Missouri	Tennessee	Texas	Mississippi	Virginia	Kansas	Oklahoma	Texas	Oklahoma	Maryland	Kansas	Iowa	New Jersey	Iowa	Missouri	Maryland	New Jersey	California	Kansas	Kansas	Ok.(1), Mo.(1)	NH1	Kansas-NC9	Missouri-NC5	Arkansas-NH1	Kansas	Missouri	Iowa	Kansas	Maryland	New Jersey	Missouri	Mo.(2), Ark.(1)
Percent[a]																																		
0	48	36	8	5	3	1	2	4	22	3	5	5	2	4	34	4	1	1	5	15	1	15	2	10	5	1		5	1	8	2	2	2	1	1
0-10	12	2	1	0	0	3	3	0	8	1	5	2	2	0	8	2	0	0	30	2	0	1	0	0	0	0		0	0	0	1	0	0	0	2
10-25	1	1	2	0	0	0	0	0	1	1	2	0	1	0	0	0	0	0	3	6	1	0	0	0	0	0		0	0	0	0	0	0	0	0
25-50	0	1	0	1	0	1	0	0	0	0	3	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0
50-75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
75-100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
Score[b]																																		
0	48	36	8	5	3	1	2	4	22	3	5	5	2	4	34	4	1	1	5	15	1	15	2	10	5	1		5	1	8	2	2	2	1	1
0-1.0	13	2	2	0	0	2	3	0	9	2	9	2	3	0	8	2	0	0	34	7	1	1	0	0	0	0		0	0	0	1	0	0	0	0
1.0-3.0	0	1	1	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0		0	0	0	0	0	0	0	2
3.0-5.0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0		0	0	0	0	0	0	0	0
5.0-7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
7.0-10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0
Ratio -/+[c]	48/13	36/4	8/3	5/1	3/0	1/4	2/3	4/0	22/9	3/2	5/10	5/2	2/3	4/0	34/8	4/2	1/0	1/0	5/34	15/9	1/1	15/1	2/0	10/0	5/0	1/0		5/0	1/0	8/0	2/1	2/0	2/0	1/0	1/2
Total Samples	61	40	11	6	3	5	5	4	31	5	15	7	5	4	42	6	1	1	39	24	2	16	2	10	5	1		5	1	8	3	2	2	1	3

[a] The samples were all placed in 6 percentage groups based on frequency, namely: (1) 0, no cork; (2) 0-10 percent cork; (3) 10-25percent cork; (4) 25-50 percent cork; (5) 50-75 percent cork; and (6) 75-100 percent cork.

[b] The samples were placed in 6 score groups based on severity, namely: (1) 0, score; (2) 0-1. 0 score; (3) 1. 0-3. 0 score; (4) 3. 0-5. 0 score; (5) 5. 0-7. 0 score; and (6) 7. 0-10. 0 score. The 0 score means no loss whereas the 10 score means a complete economic loss.

[c] The ratio is given as a fraction with the numerator representing the cork-free samples and the denominator the diseased samples.

outstanding example, of the Allgold samples from 8 States, totaling 135, only 28 showed any root symptoms; also, for the susceptible samples the "percent" and "score" values were very low.

Further examination of Table 1 reveals that although Goldrush and Red Velvet, which contain Porto Rico germ plasm, are susceptible they are less seriously diseased than Porto Rico. Like Allgold, Red Gold and Nemagold showed little injury. Jersey Orange and Yellow Jersey appeared nearly if not quite so free from root symptoms of internal cork as Allgold. Jersey Orange was affected less than Yellow Jersey.

In the table Nancy Hall and Nancy Gold are combined into one variety with abbreviations used for identification. Nancy Hall, Nancy Gold, and Red Nancy, all appeared relatively free from injury. This was also true of the Orlis and Sunnyside varieties, but the number of samples of these was rather small.

DISCUSSION

This survey has brought together valuable information to guide investigators in their present and future plans. In interpreting these results it must be remembered that the degree of necrotic injury expressed in the root symptoms was brought about after approximately 5 months' storage at a temperature favoring this expression. Data accumulated during the past 2 seasons from studies on symptomatology, seasonal development, incubation period, etc., reveal that internal cork in root samples of diseased Porto Rico may increase from less than 10 percent evident symptoms at digging time to 100 percent after 6 months' storage at 75° F. What this means is that it takes relatively long storage periods at higher incubation temperatures to cause the disease to reach the final necrotic spot phase. Incidentally, in these studies a limited number of Allgold samples showed no root symptoms at any time.

The presence of symptoms of internal cork in sweetpotato roots as revealed upon slicing is positive proof of infection, but on the other hand absence of symptoms is no proof that the causal virus is absent or that the roots are immune.

Each State agency cooperating was supplied a copy of the detailed data with the source of the samples identified. Following are a few suggestions for steps that may well be taken:

1. Return to symptom-free sources for more test material for critical indexing to determine presence or absence of virus in stocks of both susceptible and resistant varieties.
2. Study sources of symptom-free samples of sweetpotato stock varieties for propagation, and compare ecological conditions with those under which corky samples are grown.
3. Try to avoid introduction of stock from the outside into localities or onto farms where sweetpotatoes are free from internal cork.
4. Isolate any stock actually virus-free to keep it so.

In conclusion, the many important limitations of these data must be emphasized. Intelligent interpretation and application should prevent discrimination either against or in favor of all sweetpotatoes from any one State. It is hoped that a concerted effort to follow these research leads may produce substantial progress in freeing sweetpotato varieties from internal cork virus.

AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, AND MISSISSIPPI AGRICULTURAL EXPERIMENT STATION, COOPERATING

ATSEL BARLEY, A TEST PLANT FOR WHEAT STREAK MOSAIC VIRUS, AND BRIEF COMPARISONS WITH THE VIRUSES OF BROME GRASS MOSAIC AND BARLEY STRIPE MOSAIC

H. H. McKinney[1]

ABSTRACT

Atsel barley has shown variability in symptom expression which seems to indicate that it is resistant to the thirteen isolates of wheat streak-mosaic virus that serve as the basis of this report. The time required for systemic signs to appear was relatively long, ranging from 7 to 30 days from the time of inoculation. Systemic signs always appeared after the appearance of large, frequently fusiform local lesions. The systemic symptoms consisted of 1) streak-mosaic markings only, 2) fusiform lesions only, and resembling the local lesions, and 3) a combination of 1 and 2. As in wheat, there is no acute or shock phase in the development of the streak-mosaic symptoms in Atsel.

The variety has shown a high degree of susceptibility to the viruses of brome grass mosaic and barley stripe mosaic. With these viruses, systemic signs appeared 3 to 4 days after inoculation, always before the appearance of the small local lesions, and usually in all of the plants. Systemic symptoms came to expression in an entire plant population within 2 to 4 days, usually 3 days. With both viruses, there was an acute or shock phase followed by a chronic phase in the progress of the systemic symptoms. In these respects, Atsel is no different essentially from other highly susceptible varieties of barley and the susceptible wheats that have been tested against these viruses.

MATERIALS AND METHODS

Atsel barley (C.I. 6250), the variety investigated, is an exceedingly early, 6-row, spring variety with rough awns. The plant is small, producing 8 to 10, usually 9, relatively wide leaves per stalk, when conditions favor rapid growth in the glasshouse. A 4-inch clay pot provides sufficient soil to mature 5 plants, but 6-inch pots were used when a number of side-shoots were desired.

Inoculation was by the carborundum (grit No. 600) wiping method. The plants were inoculated when the third leaf was extruded 2 to 12 cm, and before the extrusion of the fourth leaf. Tests conducted in daylight were in a glasshouse or in temperature-controlled glass culture chambers located out-of-doors. The test with illumination from electrical sources was conducted in a temperature-controlled room.

Thirteen isolates of the wheat streak-mosaic virus used in these tests, and some of their characteristics, are listed as follows:

ATCC No. 29[2], the type culture, yellow streak-mosaic strain, collected in Kansas.
ATCC No. 56, green or mild streak-mosaic strain, collected in Kansas.
ATCC No. 72, resembles ATCC No. 56, collected in Colorado.
ATCC No. 85, very mild streak-mosaic strain, collected in Kansas.
Arizona, lab. No. 1, very mild signs, collected by Paul D. Keener, 1949.
Canada, lab. No. 1, moderately strong signs, collected by John T. Slykhuis, 1952.
Iowa, lab. No. 1, mild signs, collected by Iowa pathologists and the writer, 1950.
Kansas, lab. No. 41, moderate signs, collected by L. E. Melchers, 1949.
Montana, lab. No. 3, moderately strong signs, collected by the writer, 1953.
Montana, lab. No. 12, moderately strong signs, collected by the writer, 1953.
Nebraska, lab. No. 4, mild signs, collected by W. B. Allington, 1948.
New Mexico, lab. No. 1, moderate signs, collected by T. L. Harvey, 1954.
Oklahoma, lab. No. 1, moderate signs, collected by K. Starr Chester, 1948.

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[1] Acknowledgment is due Henry J. Breen and Lester W. Greeley for assistance in conducting these studies.

[2] Culture numbers assigned in the Catalogue and Registry of the Plant Viruses, The American Type Culture Collection. Washington, D. C.

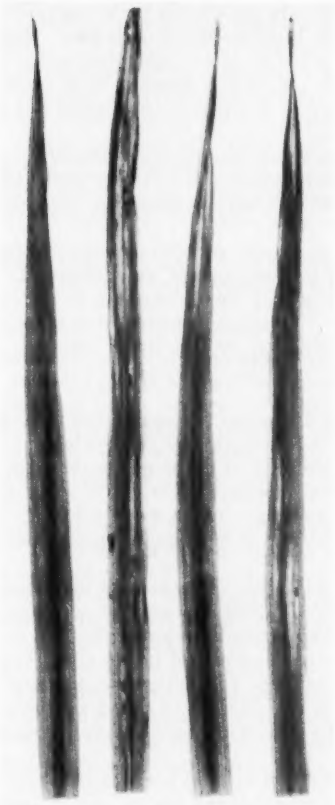

FIGURE 1. Local lesions induced by the wheat streak-mosaic virus in Atsel barley. Similar lesions sometimes result from systemic infection. Whether from local or from systemic infection, relatively rapid destruction of the involved leaf tissues follows their appearance and spread. This acute reaction does not accompany the streak-mosaic symptoms.

The degrees of expression of streak mosaic indicated for the four isolates bearing the ATCC numbers are those given in the Catalogue and Registry of the Plant Viruses. These descriptions were applied before extensive comparisons had been made with other isolates. When all of the isolates were compared on Michigan Amber winter wheat grown in a glasshouse at temperatures near 75° F, and also at summer temperatures, the type culture (ATCC No. 29) consistently induced the strongest chlorotic leaf markings, and the Arizona isolate consistently induced the weakest chlorotic leaf markings. In the case of cultures ATCC Nos. 56, 72, and 85, the chlorotic markings induced were rated moderately strong, moderate, and mild, respectively. Actually, the 13 isolates seem to represent a fairly close gradation for the degrees of chlorophyll disturbance induced under the conditions at which the comparisons were made.

Since the comparisons with the viruses of brome grass mosaic and barley stripe mosaic are very brief, a list of the cultures of these viruses will be given in a later report.

WHEAT STREAK-MOSAIC VIRUS

Tests in Daylight

Local Lesions: Although Atsel barley has shown lack of uniformity among individual plants in expression of local lesions and systemic markings when inoculated with the wheat streak-mosaic virus, populations of from 5 to 10 plants in a given test have been adequate for the studies being reported.

Local lesions always appeared first on the second leaf, and before the appearance of systemic signs, if the latter appeared at all. Each of the 13 isolates developed local lesions

in winter daylight, with the glasshouse temperatures near 75° F. Each virus isolate was inoculated into 5 seedlings, and from 2 to 5 of the seedlings developed local lesions. No essential differences in the local symptoms between the isolates were indicated. Since space did not permit the comparison of all the isolates over a range of culture conditions, these studies were confined to the type strain, ATCC No. 29, With this strain, local lesions appeared the fourth day after inoculation at 80°, the fifth day at 75°, and the sixth day at 70° F, in winter daylight.

In other tests with the type strain in a shaded glasshouse during the summer, and also at other times of the year, local lesions sometimes did not appear until the seventh day after inoculation. Under all culture conditions, the first leaf was less susceptible than the second leaf to the development of local lesions.

Local lesions appeared as small brown or chlorotic spots, and from these chlorosis developed up and down the leaf, resulting in brilliantly yellow lesions that frequently were 2 to 3 cm long or longer, and 1 to 2 mm wide. Frequently they were fusiform (Fig. 1), and brown streaks sometimes were associated with them. The leaves became completely chlorotic and necrotic, and soon died, when they had more than four or five local lesions. Death was hastened at the higher temperatures.

Systemic Reactions: In winter daylight, with the glasshouse temperatures near 75° F, each of the 13 isolates induced systemic signs in from 1 to 5 plants of the 5-plant populations that were tested. In tests with the type strain (ATCC No. 29) at three temperatures, systemic signs appeared the tenth day after inoculation at 80°, the nineteenth day at 75°, and the eighteenth day at 70° F. The number of plants developing systemic signs were 5 at 80°, 1 at 75°, and 1 at 70° F, in the 5-plant populations. In the test at 80° F the plants showed the first systemic signs over a period of 11 days.

Systemic signs were of three types. One conformed to the conventional streak-mosaic pattern, another consisted of yellow or brownish "acute" lesions that essentially were like the local lesions illustrated in the figure, and a third was a combination of the two in the same plant. Sometimes the streak mosaic and the lesions were intermixed in the same leaf, and sometimes the lesions appeared independently in later leaves, following the expression of streak mosaic in earlier leaves on the same plant. The occurrence of these systemic acute lesions was very erratic, but they were induced in some plants by each isolate, except the one from Colorado.

In tests conducted with the type strain ATCC No. 29 in a shaded glasshouse during the summer, systemic signs developed in from 40 to 100 percent of the plants in populations of 15 to 20 plants each. First systemic signs appeared from the tenth to the seventeenth day after inoculation. Within a given test population, the plants showed the first systemic signs over periods ranging from 2 to 20 days.

Fluorescent Light Compared with Daylight

The type strain was tested at temperatures near 75° F in daylight during March, and with fluorescent light. Illumination at the soil line was 740 foot-candles with the fluorescent source. The daily photoperiod was approximately 12 hours at both locations.

Local Lesions: The local lesions were evident at 8 A.M. on the fifth day after inoculation in the plants cultured with fluorescent light, and 7 hours later in the plants cultured in daylight. Lesions had appeared in all of the 10 plants under fluorescent light by 4 p.m. on the fifth day, and in all 10 plants under daylight by 4 p.m. on the sixth day, after inoculation. Progress of the lesions, and the collapse of the involved leaves were much more rapid in the fluorescent light than in daylight.

Systemic Signs: In fluorescent light, 3 of the 10 plants expressed streak mosaic, the other 7 plants remaining free from systemic signs. With the 3 plants, systemic signs appeared on the twelfth, fourteenth, and twentieth days after inoculation. In daylight, systemic signs did not appear in any of the 10 plants.

UNUSUAL REACTIONS PRODUCED BY SOME ADDITIONAL ISOLATES

Another isolate that is regarded as wheat streak-mosaic virus rarely induced local lesions in Atsel barley but it induced streak mosaic more regularly than did any of the other isolates.

It rarely induced the systemic acute lesion and streak-mosaic symptoms in the same plant, and the systemic acute lesion did not occur alone in any of the tests. As in the case of the 13 isolates discussed above, the time required for systemic signs to appear tended to be long, ranging from 6 to 13 days from the time of inoculation, with culture near 75° F. This isolate and another isolate that is considered to be wheat streak-mosaic virus show an unusual tendency to cause very marked dwarfing and sometimes malformations in certain test plants. Since these reactions suggest synergistic reactions from mixed infections by different viruses[3], these isolates are being studied further to determine their purity. If synergistic reactions are not involved, it is evident that some strains of the wheat streak-mosaic virus have unique capacities for inducing unusual morphological reactions in some test plants when grown in a suitable environment.

THE VIRUSES OF BROME GRASS MOSAIC AND OF BARLEY STRIPE MOSAIC BRIEFLY COMPARED WITH THE VIRUS OF WHEAT STREAK MOSAIC

Atsel barley seems to represent a resistant type that shows considerable variability among plants with respect to the expression of local and systemic reactions induced by the isolates of wheat streak-mosaic virus considered in this report. However, the variety is uniformly very susceptible to the viruses of brome grass mosaic and barley stripe mosaic. When inoculated with a given isolate of either of these viruses, and with culture over a wide range of conditions, the reactions were essentially uniform among the several plants comprising a test unit. As with many other test plants, off-type plants appear occasionally, but these have been rare in Atsel.

With the viruses of brome grass mosaic and barley stripe mosaic, the first signs were systemic. They appeared the third to the fourth day after inoculation, when culture was at temperatures near 75° F in winter daylight or at summer temperatures in a shaded glasshouse. Small local lesions did not appear in the wiped leaves until after the expression of systemic signs. Furthermore, with both viruses, the systemic disease syndromes in Atsel comprised acute and chronic phases, as is true of all other susceptible barleys and wheats that have been tested thus far with these viruses.

With the wheat streak-mosaic virus isolates tested in Atsel barley, the local lesions always appeared before the systemic signs, and when systemic signs did appear there was always a relatively long interval between the time of inoculation and the time of expression (7 to 30 days). The systemic disease syndrome consisted of the streak-mosaic markings, the occasional fusiform lesions, or both. However, with the streak-mosaic markings, acute and chronic phases were not evident. Wheat varieties tested thus far likewise do not manifest acute and chronic systemic phases when infected with the strains used in these studies.

Some strains of the barley stripe-mosaic virus can be confused with the brome grass-mosaic virus in Atsel barley, as in many other varieties of barley and wheat. In seedlings of Golden Giant sweet corn grown at warm temperatures, the brome grass-mosaic virus regularly induces many local lesions and systemic necrosis, followed by death of the seedling. On the other hand, this sweet corn variety has given irregular results when inoculated with strains of the barley stripe-mosaic virus. Some strains have failed to induce systemic signs. Furthermore, the local-lesion reaction and the systemic reaction have been inconstant with a given strain of the virus. When systemic signs do develop, they consist of yellowish-green and yellow stripes in the leaves. Usually the plants are stunted badly, but they have never been killed under the usual culture conditions that favor killing of the seedlings by the brome grass-mosaic virus.

Golden Giant sweet corn has also shown irregularities in its reaction to some of the isolates of the wheat streak-mosaic virus.

The fact that barley stripe-mosaic virus is seedborne in Atsel barley and in many other barleys and in many wheats, serves to differentiate this virus from the other viruses under discussion.

FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, BELTSVILLE, MARYLAND

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[3]McKinney, H. H. 1956. Interference and synergistic reactions with respect to barley stripe-mosaic virus and brome mosaic virus. Plant Dis. Reptr. 40: 520-523.

INHERITANCE OF THE BARLEY STRIPE MOSAIC RESISTANCE OF MODJO (C.I. 3212) AND C.I. 3212-1[1]

W. W. Sisler and R. G. Timian[2]

Abstract

Modjo (C.I. 3212) and C.I. 3212-1 are resistant to all strains of barley stripe-mosaic virus tested. F_2 progenies from crosses of these varieties to susceptible types were inoculated with the California "E" isolate of stripe mosaic. Ratios of infected to free F_2 plants indicated that two genes are involved in the inheritance of the reaction of Modjo and C.I. 3212-1 to barley stripe-mosaic virus.

In 1954 two barley world collection entries, Modjo (C.I. 3212)[3] and C.I. 3212-1, were found to have resistance to barley stripe mosaic virus[4]. Subsequent tests have substantiated the fact that they carry a fairly high degree of resistance to this virus. Stripe mosaic investigations under way at this and other stations are making extensive use of Modjo and C.I. 3212-1.

In a previous paper[4] it was stated that the progeny from crosses of Modjo and C.I. 3212-1 with susceptible varieties after inoculation with stripe-mosaic virus, segregated in a ratio of 3 plants with symptoms to 1 plant with no symptoms. Shortly after inoculation a ratio of 1 plant with symptoms to 3 with no symptoms was noted. As incubation time increased more plants developed symptoms until at the conclusion of the trial the 3:1 ratio was obtained.

Recent studies have shown that temperature and light are extremely important in the production of stripe mosaic symptoms, particularly in plants that possess a high degree of tolerance of the virus. In the present study more emphasis was placed on temperature and light control in an effort to obtain symptom expression in all infected plants. The range of symptom severity and the variation in incubation time may be affected by environmental conditions, the genetic constitution of the plants, and the presence of more than one strain of the virus. In this study the California "E" isolate of stripe-mosaic virus was used but no attempt was made to determine whether it was composed of more than one strain.

In the present study F_2 progenies of the crosses C.I. 3212-1 x 5583 and Traill x Modjo were inoculated in the seedling stage with the California "E" isolate of stripe-mosaic virus and the date of symptom expression was recorded. Expressed sap from leaves of plants that did not show symptoms after 16 days were used to inoculate seedlings of Black Hulless (C.I. 666), a susceptible variety used as a tester, to check for the presence of the virus in a latent condition or in the form of a very mild strain. Periodic observations were made of the remaining symptomless plants and all were checked on the tester variety 3 additional times, at 25-day intervals.

Column one in Table 1 shows the number of plants that expressed symptoms during the first 16 days after inoculation. Column 2 lists the number of plants in which the virus was first detected by use of the tester variety. Some of these plants, however, expressed symptoms some time after the virus had been shown to be present by testing on Black Hulless.

The susceptible parent in each cross expressed symptoms within 16 days after inoculation. Since seed of the resistant parent plants used in the crosses was not available, seed from bulk samples of the varieties was tested. Fourteen of the 16 plants of each resistant parent variety were apparently free from the virus. Two plants of each resistant parent proved to be infected when tested on Black Hulless 72 days after the original inoculation.

Sixteen days after inoculation a ratio of 3 plants with symptoms to 1 plant showing no

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[1] Published with the approval of the Director of the Agricultural Experiment Station, Fargo, North Dakota.

[2] Assistant Agronomist, North Dakota Agricultural Experiment Station, Fargo, North Dakota, and Plant Pathologist, Field Crops Research Branch, Agricultural Research Service, United States Department of Agriculture, respectively.

[3] C.I. refers to accession number of Cereal Crops Section, Field Crops Research Branch, Agricultural Research Service.

[4] Timian, R. G. and W. W. Sisler, 1955. Prevalence, sources of resistance, and inheritance of resistance to Barley Stripe Mosaic (False Stripe). Plant Dis. Reptr. 39: 550-552.

Table 1. Number of parent and F_2 plants from two barley crosses shown to be infected after inoculation with the California "E" isolate of stripe-mosaic virus, and ratios of symptom-showing to symptomless and infected to free plants.

F_2 family or parent	Number of plants shown to be infected			
	3-16 days after inoculation	17-94 days after inoculation	No infection detected	Total plants
C.I. 3212-1	0	2	16	18
5583	16	0	0	16
C.I. 3212-1 x 5583 (6)	26	14	5	45
" " (7)	39	8	0	47
" " (8)	32	11	3	46
" " (9)	35	7	4	46
" " (10)	32	7	6	45
Total F_2	164	47	18	229
Ratio:				P
3:1	164	65		.2-.3
15:1	211		18	.3
Modjo	0	2	16	18
Traill	14	0	0	14
Traill x Modjo (1)	39	8	3	50
Traill x Modjo (2)	46	12	3	61
Traill x Modjo (3)	40	13	2	55
Total F_2	125	33	8	166
Ratio:				P
3:1	125	41		.9
15:1	158		8	.4

symptoms was obtained in each cross. This is in agreement with the previous study. During the next 78 days more plants were found to contain the virus, and at maturity a ratio of 15 infected plants to 1 apparently free was obtained.

This showed that at least two genes are involved in resistance to stripe-mosaic virus. The "resistant" F_2 plants should have been homozygous for no symptom expression. Progeny from each symptomless plant which produced seed was grown and inoculated. One progeny was segregating for symptom expression and all others produced no symptoms either on the inoculated seedlings or the tester variety.

The variety 5583 was used to test for association between stripe mosaic reaction and several agronomic characters. Tests for independence and association on the progeny of C.I. 3212-1 x 5583 showed that genes conditioning stripe mosaic reaction were independent of Bb (black-white kernel), Kk (hoods-awns), Nn (hulled-naked caryopsis) and Ss (length of rachilla hairs).

From these data it is concluded that at least two genes control stripe mosaic reaction in Modjo and C.I. 3212-1. This conclusion is based on the above methods of testing for presence of the virus. This study indicates that good tolerance of stripe mosaic could be transferred from Modjo or C.I. 3212-1 to commercial varieties of barley with little or no difficulty.

FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, AND NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION, FARGO, NORTH DAKOTA

VINCA YELLOWS IN MEXICO

Karl Maramorosch

Summary

A typical aster-yellows-like virus disease was observed in a subtropical region of Mexico. Vinca rosea plants affected by the disease showed color breaking and virescence of flowers and growth of secondary shoots. This Vinca yellows was studied in a greenhouse in a temperate climate where its severity increased, as manifested by the production of extremely short internodes, numerous chlorotic secondary branches, and very small leaves. Summer temperatures caused partial recovery of infected plants; high temperature was probably also responsible for the somewhat milder form of disease in nature. The virus was transmitted by dodder to carrot plants. It was not transmitted by the aster leafhopper from Vinca or carrot plants to carrot or China aster. It was concluded that Vinca yellows belongs to the group of yellows-type diseases and that it is distinct from aster yellows. No yellows-type disease had been reported from Mexico previously.

During a field survey of virus diseases in Mexico, carried out during the summer of 1956[1], a typical yellows-type disease of Vinca rosea L. (periwinkle) was observed in Cuernavaca, a locality situated in the mild subtropical region 50 miles west of Mexico City. The diseased plants were found at an elevation of ca. 5000 feet above sea level. During the latter part of July, when many Vinca plants were in bloom, marked breaking of color and virescence of flowers were noticed in 10 to 15 percent of the plants (Fig. 1). The disease superficially resembled aster yellows in Vinca rosea (3). Typical signs included a witches'-broom effect, caused by secondary shoots.

Diseased scions from Cuernavaca were brought to a greenhouse in a temperate climate and grafted onto healthy stock plants of Vinca, grown from seed. The disease progressed slowly and at first affected some but not all branches. Several months elapsed before the entire plant became systemically infected, as manifested by severe stunting, chlorosis, and reduced size of leaves (Fig. 2, A). During the following summer, when greenhouse temperatures during noon hours often reached 100° F, diseased Vinca plants recovered partially (Fig. 2, B). The development of normal leaves during the hot period indicated that the causative virus was heat labile at a temperature that did not affect the plants adversely. In this respect the virus resembled aster yellows (2) and several other heat-labile yellows viruses (1, 2, 4, 5, 6, 7). However, internodes of Vinca plants with Mexican yellows were extremely short, approximately 4 mm in length, while plants with aster yellows had internodes 14 mm long, and healthy controls under similar growing conditions had internodes 20 mm in length (Fig. 3, A, B, C).

While many virescent or broken flowers were seen in Cuernavaca, no flowers whatsoever were formed in the greenhouse in a cooler region. On the other hand, the severe stunting, the striking chlorosis, and the formation of tiny leaves observed in cooler conditions, were not seen in nature. An attempt was made to reproduce the milder signs of disease by increasing the temperature to an average of 80° F. Within 5 weeks, Vinca plants inoculated by grafting showed the characteristic virescence and breaking of flower color, at the same time retaining the larger-sized leaves. Year-round warm weather in the subtropical climate probably resulted in a reduction of virus concentration in infected Vinca plants, which in turn was manifested by milder signs of disease.

It was pointed out by Kunkel (personal communication) that many typical yellows-type viruses that infect carrot (Daucus carota) plants cause similar signs of disease in that host. Carrot plants can therefore serve as indicators of the general type of yellows disease, but not as indicators of specific yellows diseases. Vinca yellows was easily transmitted by means of dodder (Cuscuta subinclusa) to carrot plants; the infected plants were, as expected, almost indistinguishable from carrot plants with aster yellows.

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[1] This investigation was supported in part by a grant from the Rockefeller Foundation. Facilities for carrying out this study were provided by the Agricultural Program of the Foundation in Mexico.

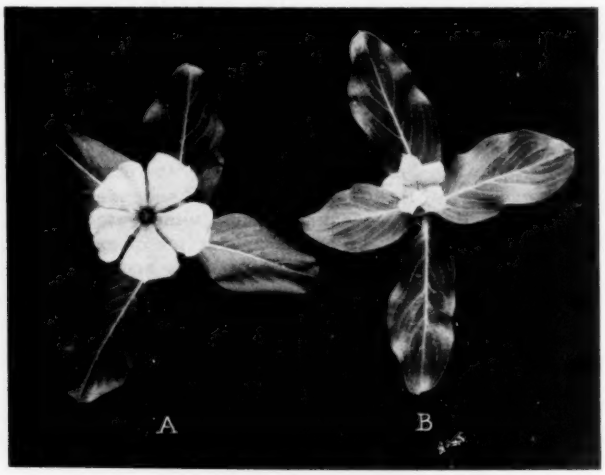

FIGURE 1. A -- Virescent flower of Vinca rosea. B -- Normal flower. Photographs by J. A. Carlile.

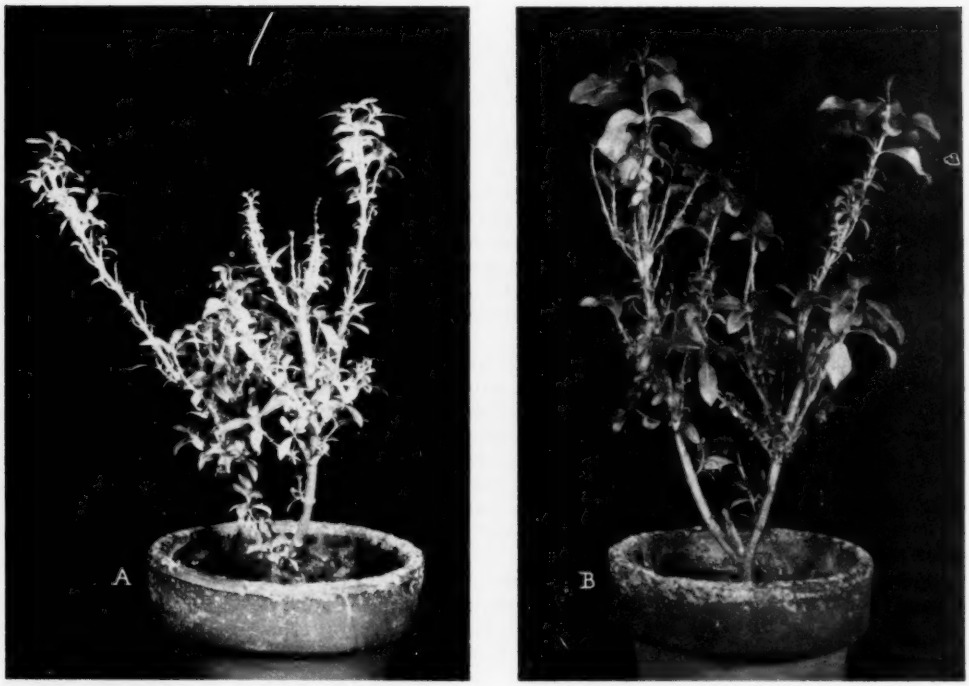

FIGURE 2. A -- Vinca rosea with severe signs of yellows. B -- Same plant, partially recovered after a hot summer. Photographs by J. A. Carlile.

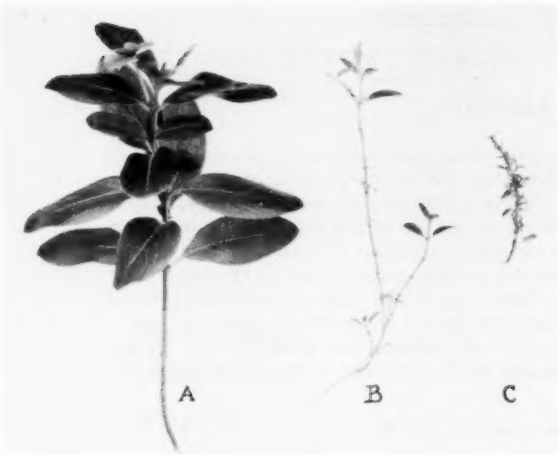

FIGURE 3. A -- Healthy periwinkle plant, internodes 20 mm in length. B -- Periwinkle with aster yellows, internodes 14 mm in length. C -- Periwinkle with Vinca yellows, internodes 4 mm in length. Photographs by J. A. Carlile.

An attempt was made to transmit the virus from diseased Vinca and carrot plants to carrot and China aster (Callistephus chinensis) by means of the aster leafhopper Macrosteles fascifrons. Fifty virus-free leafhoppers from stock maintained on rye (Secale cereale) plants were caged on diseased Vinca and carrot plants for one week. Afterwards the insects were transferred to a succession of carrot and aster seedlings for the remainder of their lives. All exposed plants remained healthy.

Vinca yellows is as far as known, the first typical yellows disease reported from Mexico. The difference in disease signs of the Mexican disease and of aster yellows in Vinca, together with the inability of M. fascifrons to transmit the causative agent, indicate that Vinca yellows is not identical with aster yellows. All known vectors of typical yellows-type viruses belong to the family Cicadellidae. Presumably a future search for the vector of the newly described disease can safely be limited to cicadellid leafhoppers. The heat sensitivity of the virus may explain why the disease has not reached economic importance under the climatic conditions of the region where it was found. Its host range, distribution, and insect transmission are still unknown.

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REACTION OF DUTCH IRIS VARIETIES TO PUCCINIA IRIDIS IN NORTH CAROLINA

N. N. Winstead, J. M. Jenkins, Jr., and F. A. Haasis

ABSTRACT

Plants of 46 varieties of Dutch iris were inoculated with urediospores of Puccinia iridis. Varieties differed in reaction to the rust fungus, ranging from highly resistant, showing no visible symptoms or only a hypersensitive reaction, to highly susceptible. No reproduction of the fungus was observed on plants of the varieties Golden Show and Goudstuk. Plants of the varieties Early Blue, Gold and Silver, Golden West, Imperator, Lemon Queen, and Texas Gold were rated as 1 or very resistant. The disease indices obtained in North Carolina differed from those previously reported by Mains on the varieties Golden Bronze, Imperator, Mauve Queen, and Wedgewood. Prior to 1954, the Dutch iris rust disease had been observed in North Carolina in 1928, 1939, and 1949.

In the spring of 1954, plants of Dutch iris, Iris spp. (I. filifolia Boiss., I. tingitana Boiss. & Reut., and hybrids), severely affected with rust incited by Puccinia iridis (DC.) Walh., were observed in the Dutch iris variety test at the Horticultural Crops Research Station, Castle Hayne, North Carolina. The rust disease has been observed only sporadically on Dutch iris in North Carolina. A grower observed the disease in the Castle Hayne area in 1928, 1939, and 1949 on the variety D. Haring. In these cases specimens were sent to and diagnosis was made by Freeman Weiss in 1928 and 1939, and F. A. Haasis in 1949.

Mains[1, 2] has described three races of the Dutch iris rust fungus: P. iridis australis,

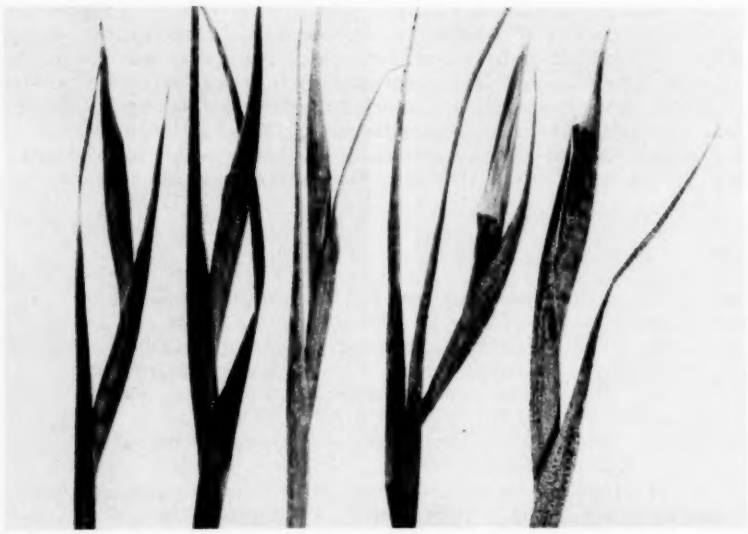

FIGURE 1. Plants of the Golden Show, Lemon Queen, Mauve Queen, LeMongol, and Marconi, Dutch iris varieties showing 0, 1, 2, 3, and 4 reactions to Puccinia iridis, respectively.

[1] Mains, E. B. 1934. Host specialization in the rust of iris, Puccinia iridis. Amer. Jour. Bot. 21: 23-33.

[2] Mains, E. B. 1938. Additional studies concerning the rusts of iris, Puccinia iridis. Phytopathology 28: 67-71.

Table 1. Reaction of Dutch iris varieties to Puccinia iridis, North Carolina, 1954.

Variety	Disease Index[a]	Variety	Disease Index[a]
Alaska	4	Marquette	4
Albino	4	Mauve Queen	2
Belle Jaune	2	No. 97 (seedling)	1
Blue Champion	4	Orange Glow	4
Blue Pearl	4	Orange King	4
Blue Triumphater	3	Orange Van	2
Bronze Beauty	3	Princess Beatrix	4
Early Blue	1	Princess Irene	4
Gold and Silver	1	Professor Blauw	3
Golden Bronze	3	Rijzende Zon	2
Golden Emperor	2	Royal Yellow	2
Golden Show	0	Saxe Blue	3
Golden West	1	Stranger	2
Goudstuk	0	Subliem	3
Harmony	4	Sunshine	2
Imperator	1	Texas Gold	1
Jeanne D'Arc	4	Van Everdinger	2
King Mauve	4	Van Vleets	4
Lemongel	3	Wedgewood	3
Lemon Queen	1	White Pearl	4
Lemon Wonder	2	White Perfection	3
Lilac Queen	2	White Superior	4
Marconi	4	Yellow Mammouth	3

[a] Each index rating was derived by scoring twenty plants individually.

P. iridis californica, and P. iridis septentrionalis. In 1938 Mains reported the reaction of 35 varieties of the Xiphium section of the Iris genus to the races californica and septentrionalis. This study reports the reaction of 46 varieties, including 5 of the varieties tested by Mains, to the isolate present in North Carolina in 1954.

MATERIALS AND METHODS

When the disease was observed on plants of the Alaska variety urediospores were collected. Five plants of each of the 46 varieties in the trial were inoculated in the field with an aqueous suspension of urediospores. Although disease development was more rapid on the

Table 2. Comparison of reactions of certain Dutch iris varieties to a North Carolina isolate of Puccinia iridis in 1954 with reactions of the same varieties to the californica and septentrionalis races of P. iridis as reported by Mains in 1938.

	Disease Index		
Variety	North Carolina Isolate	Reported by Mains in 1938 P. iridis race californica	P. iridis race septentrionalis
Golden Bronze	3	4	-
Imperator	1	0	0
Mauve Queen	2	4	4
Van Everdinger	2	0-1	2
Wedgewood	3	1	0-1

inoculated plants, spores were also disseminated by natural means, and the disease was present throughout the planting.

The 5 inoculated plants of each variety as well as 15 additional plants were rated for disease reaction according to the following system: 0, immune, or only hypersensitive flecking and no sporulation; 1, very resistant, uredia minute and few, surrounded by a necrotic or chlorotic zone; 2, few small to medium sized uredia or isolated medium sized pustules in a chlorotic zone; 3, uredia medium, coalescing infrequently, chlorotic zones sometimes present; and 4, uredia large, numerous and confluent, no necrosis or chlorosis.

EXPERIMENTAL RESULTS

Varieties differed in their reaction to the isolate of P. iridis used in these tests; however, all plants within a particular variety were uniformly diseased. Reactions ranged from immune to very susceptible. While several varieties including Early Blue, Gold and Silver, Golden West, Imperator, Lemon Queen, No. 97 (seedling), and Texas Gold were rated as 1 or very resistant, only two varieties, Golden Show and Goudstuk, were placed in the 0 class. Disease indices of the 46 varieties included in this test are listed in Table 1. Typical reactions of plants rated 0, 1, 2, 3, 4 are shown in Figure 1.

The californica and septentrionalis races were tested by Mains in 1938 on five of the varieties included in this test. A comparison of the reaction obtained in this test with those reported by Mains is given in Table 2. Plants of the Wedgewood variety, reported by Mains as falling into the classes 0 or 1 with either of the two rust races with which he worked, were susceptible to the inoculum used in this test. Furthermore, the variety Mauve Queen, which was susceptible to both races in Mains' tests, was moderately resistant in this test. Plants of the Golden Bronze variety were rated as susceptible in this test, and as very susceptible to the californica race. In Mains' experiments plants of the Imperator variety were immune from both races of P. iridis. However, in this test, slight sporulation occurred on all plants of this variety. Attempts were made to confirm these results in 1955, but the rust inoculum collected in 1954 was no longer viable. Since reactions on four varieties differed from those described by Mains, it is possible that a new strain or race was present in North Carolina in 1954.

PLANT PATHOLOGY, NORTH CAROLINA STATE COLLEGE, RALEIGH, AND HORTICULTURAL CROPS RESEARCH STATION, CASTLE HAYNE, NORTH CAROLINA

OVULINIA FLOWER SPOT OF AZALEA FOUND ON LONG ISLAND

Paul E. Nelson[1], C. E. Williamson[1], and W. D. McClellan[2]

In March 1956 a greenhouse grower of cut flowers and potted plants in the Washington, D. C., area received a shipment of potted azaleas from a grower-wholesaler located on Long Island, New York. When these azaleas, then nearly in full flower, were received some of the flowers were "melted" down and others had soft, watery lesions characteristic of azalea flower spot. When affected flowers were incubated in a moist chamber the moist, pitted, black sclerotia of Ovulinia azaleae Weiss developed rapidly. In April additional specimens were obtained and examined microscopically. Distinctive one-celled, hyaline spores with basal disjunctor cells were abundant on the soft, watery lesions. In a moist chamber these specimens also produced characteristic sclerotia. The fungus was obtained in pure culture on potato-dextrose agar by several single-conidium isolates. This is the first record of azalea flower spot north of Maryland. According to the records of the Plant Disease Survey, this disease has been recorded from Maryland to Florida and west to Texas and from California.

According to Weiss and Smith[3] a temperature range of 50° to 72° F and occasional or frequent periods when the flowers are wet are favorable to the development of azalea flower spot. Essentially these conditions prevail when outdoor azaleas flower in the North and they occur regularly in azalea-forcing greenhouses. Most potted azaleas are forced at 60° to 70° F, but the temperature may be dropped to 50° to 60° if the flowers are opening too early for a particular holiday. In many greenhouses the temperature is not closely regulated. Thus the heat may not be turned on in the afternoon until the temperature drops well below the established night temperature. Under high humidity conditions the sudden temperature drop in late afternoon could condense a film of moisture on the flowers.

Doubtless Ovulinia azaleae has been introduced into the North in shipments of plants from Southern States. Although it is conceivable that survival of sclerotia might be limited by unfavorable conditions out-of-doors in the North, there is no question but what the greenhouse environment provides not only favorable conditions, but also an abundance of inoculum. Ample inoculum is provided by sclerotia, both in old flower tissue and free, that drop to the ground and remain undetected. Unsold plants forced one year and held over for forcing again the following year also are a source of inoculum.

The Long Island grower believes that this disease was seen first during the winter of 1952-53. Plants had not been imported for at least one or two years prior to that time. The disease usually has appeared about the middle of December, coinciding more or less with the flowering of the first forced azaleas, and has continued into April when the last plants are flowered. According to this grower the disease is important at temperatures of 60° to 70° F, but the greatest loss occurred when the temperature was dropped to 50° to 60° to prevent the flowers from opening too soon.

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[3] Weiss, Freeman, and Smith, Floyd F. 1940. A flower-spot disease of cultivated azaleas. U. S. Dept. Agr. Circular 556: 1-28.

HOT-WATER SEED TREATMENT FOR CONTROL OF A ROOT ROT COMPLEX OF STRELITZIA REGINAE

Richard D. Durbin

Bird-of-paradise, Strelitzia reginae Banks, has become increasingly important as an outdoor and container-grown ornamental[1]. In the past, seed sources for this plant have been mainly the Hawaiian Islands, but local sources are now being developed. One of the main problems encountered has been the variability in the number of salable plants produced from the various seed lots. Germination percentages of untreated seed commonly range from 0 to 80. A major portion of this variation is ascribable to a fungus complex, involving an internally-borne Fusarium sp., which rots the seed and roots. Infected plants which do emerge are stunted, chlorotic, and have extensively damaged lateral roots. In the later stages of disease the main tap root is also involved. Since bird-of-paradise normally requires about 2 1/2 months for seed germination and does not reach full flower productivity until 8 years old, it is in a condition susceptible to disease for a long period. Loss of roots also greatly increases grower costs, since more time is required to bring the plants to maturity and many are lost in the interim.

A series of eradicative seed treatments using hot water at various temperatures was tested during 1955-56. The seed lots were presoaked for 1 day in water at room temperature. They were then immersed in hot water at different constant temperatures at 5° intervals between 115° and 140° F for 30 minutes. Immediately after treatment they were cooled by plunging in clean cold water, and then dried. The planting medium was treated with methyl bromide or steam-sterilized.

FIGURE 1. Comparative root systems of Strelitzia reginae. Healthy roots on left produced from seed treated at 135° F for 30 minutes. Shriveled dead roots on right were produced from non-treated seed. Peat particles which could not be washed off are evident on many roots.

Control of the disease was not adequate at temperatures of 125° F and below. Although a reduction of pre-emergence damping-off was achieved at these temperatures, subsequent damage to the lateral roots was noted. In all tests 140° was injurious. The best results were obtained using 135° for 30 minutes (Fig. 1). Results from a typical test gave 12 percent germination in the untreated check, 56 at 125°, 71 at 130°, 78 at 135°, and 27 at 140° F.

DEPARTMENT OF PLANT PATHOLOGY, UNIVERSITY OF CALIFORNIA, LOS ANGELES 24

[1] Anon. 1956. The Strelitzia reginae. Flor. Rev. 118 (3068): 29-31, 114-116.

ALUMINUM FOIL AS AN AID TO INOCULATION WITH PHYSALOSPORA OBTUSA

Patrick M. Miller

Frog-eye leaf spot of apples, caused by Physalospora obtusa (Schw.) Cke., appeared more widely than normal in Connecticut in May and June of 1956. Therefore, it was decided to determine whether it could be controlled by some of the new and other fungicides already being assayed for apple scab control. It was thought necessary to supplement the light and erratic natural infection of frog-eye already present in the plots with artificial inoculation to obtain a heavier and more uniform infestation. Since natural infections normally occur much earlier in the season, special procedures would have to be used to obtain infection and to keep the amount of inoculum needed to a reasonable amount. Hoadly (1) found that wrapping leaves or fruit of tomatoes with aluminum foil increased infection with grey leaf spot caused by Stemphylium solani G. F. Weber, and anthracnose caused by Colletotrichum phomoides (Sacc.) Chester. These results suggested that foil might be used to similar advantage in this test to obtain good infection with P. obtusa on apples.

An isolate of P. obtusa was obtained from an infected leaf and grown on Emerson's medium in 500-ml Erlenmeyer flasks on a shaker. Then the mycelial mats were chopped in a Waring blendor for 1 minute and diluted with two volumes of distilled water.

Plots consisted of three dwarf McIntosh apple trees. The fungal inoculum was applied on July 1 with a syringe atomizer (2) to the third and fourth leaves of 10 shoots in each of the 4 replicates. The tip and other leaves on the shoot were removed prior to inoculation for ease of wrapping with the foil. After inoculation the two leaves were enclosed with 6 x 6-inch square of aluminum foil to prevent drying of the inoculum and the leaf surfaces. These foil squares were left on the shoots for 4 days, when they were taken from the inoculated leaves and twisted around the shoot to serve as a marker. Inoculum was also placed on other shoots, which were kept moist for 16 hours by irrigation or rain to serve as comparison plots for the use of the foil.

Results were obtained by removing the inoculated leaves from twigs and counting the number of infections per leaf.

RESULTS AND DISCUSSION

Unsprayed leaves on which moisture was retained by the use of foil averaged 13 spots per leaf; leaves on which moisture had been supplied by irrigation averaged 3 spots per leaf; and uninoculated leaves averaged 1 spot per leaf. None of the fungicides gave satisfactory control of infection under conditions of this test, for sprayed leaves ranged from 8 to 19 spots per leaf.

However, the advantage of using aluminum foil to retain moisture for artificial infection is evident. A very heavy infection of P. obtusa was obtained with its aid at a time when natural infections rarely occur. The natural infection period for this fungus is late April, May, or early June. Use of foil should facilitate similar tests on other foliar diseases of apples or other fruits. It is much easier to handle than plastic bags and makes possible the use of a small amount of inoculum. Wrapping the foil around the twig after inoculation makes a convenient method of marking inoculated twigs.

Literature Cited

1. Hoadley, A. D. 1951. A method for making artificial field inoculations on the leaves and fruit of tomatoes. (Abstr.). Phytopathology 41: 658.
2. Miller, P. M. 1956. Use of hypodermic syringe and needle as an atomizer. Plant Dis. Reptr. 40: 755.

DEPARTMENT OF PLANT PATHOLOGY AND BOTANY, CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

PERFORMANCE OF APPLE SCAB FUNGICIDES UNDER SEVERE INFECTION CONDITIONS

Patrick M. Miller

SUMMARY

Under severe test conditions of artificial inoculation followed by 10 inches of water, Mesulfane, Norsulfane, Thioneb, thiram wettable powder, and captan gave excellent control of apple scab (Venturia inaequalis) at 2 lbs per 100 gallons, as did thiram paste at 3 lbs. Thiram paste gave better control than thiram wettable powder, probably owing to better residual power. Dichlone at 1/8 lb gave poor control, but excellent control at 1/4 lb or more. It is suggested that 1/4 lb of dichlone is adequate for normal spraying of apples.

It is under epiphytotic conditions that differences in fungicidal properties of different materials are most apparent. Yet such conditions occur infrequently and weaknesses in some fungicides may not become apparent until after several years of testing under natural infection conditions. This test was designed to test control of apple scab (Venturia inaequalis) by some new as well as some commonly-used fungicides under very severe conditions.

MATERIALS AND METHODS

For a source of inoculum on May 12 and June 2, apple leaves which had fallen from heavily infected trees and overwintered beneath these trees were chopped up with a rotary lawn mower. About 20 pounds of chopped leaves were soaked overnight to obtain ejection of the ascospores from the perithecia into the water. More water was added to this mixture to increase the volume to 30 gallons, and then the mixture was agitated for several minutes. The end of the intake hose of the sprayer was wrapped in burlap to serve as a filter. The ascospore suspension was then applied at 300 pounds pressure with a hand spray gun. Immediately after inoculation 1 inch of water per hour was applied by irrigation for 9 hours. After each inoculation the irrigation was followed by about 1 inch of rainfall lasting several hours. The irrigation plus the rain provided good infection periods and also a very thorough test of the residual properties of the fungicides.

Each plot consisted of three McIntosh dwarf apple trees planted in plots arranged in a spiral, as previously described by Horsfall and Rich[1]. Treatments were replicated four times. Applications were made on May 7, 14, 22, and 28, June 5, 14, 19, and 28. Fungicides and amounts added to 100 gallons of water were: Mesulfane (N-methanosulfon-N-trichloromethanomercapto-4-chloranilide), 2 lbs; Norsulfane (N-methanosulfon-trichloromethanomercapto-anilide), 2 lbs; Thioneb (polyethylene thiuram monosulfide), 1/2 and 2 lbs; thiram wettable powder (bis(dimethyl)thiocarbamyl)disulfide), 65% active, 2 lbs; thiram paste, 40% active, 3 lbs; dichlone (2, 3-dichloro-1, 4-naphthoquinone), 1/8, 1/4, 1/2, and 1 lb; and captan (N-trichloromethylmercapto-4-cyclohexene-1, 2-dicarboximide), 2 lbs.

Ratings of the infection obtained were made on June 12. At this time leaves which had developed after inoculation were free from scab and interfered with determination of the scab severity on the basis of percent infected leaves. Therefore the severity of the scab was estimated by rating each tree on a scale ranging from 1 = no visible infection to 10 = heavy general infection.

RESULTS AND DISCUSSION

The results are given in Table 1. All the materials at 2 pounds to 100 gallons, or at the higher concentrations used, gave excellent control of scab even though leaves on unsprayed trees were heavily infected, averaging 20 to 25 spots per leaf, at least double the number of natural infections on trees in other parts of the farm. The thiram paste gave better control than

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[1] Horsfall, James G., and Saul Rich. 1949. Spirally arranged plots in a design for field assay of fungicides. Connecticut Agr. Exp. Sta. Bul. 530.

Table 1. Fungicidal control of apple scab on inoculated trees.

Treatment[a]	Amount added lbs/100 gallons	Ratings of severity[b] of scab infection
Mesulfane	2	1.5
Norsulfane	2	1.4
Thioneb	1/2	5.2
Thioneb	2	1.5
Thiram-powder	2	2.7
Thiram-paste	3	1.5
Dichlone	1/8	5.1
Dichlone	1/4	2.1
Dichlone	1/2	1.4
Dichlone	1	1.6
Captan	2	1.6
Unsprayed	-	9.2

[a] Applications on 5-7, 5-14, 5-22, 5-28, 6-5, 6-14, 6-19, and 6-28.

[b] Scab result of 2 inoculations on 5-12 and 6-2. Scab severity ratings are average of 4 replicates and are based on scale ranging 1=no infection to 10 = all leaves severely infected.

the thiram wettable powder although equivalent amounts of thiram were applied in each case. Apparently the 10 inches of water that fell on the trees following inoculation removed a greater proportion of the thiram wettable powder than of the paste, because leaves sprayed with the powder were more severely infected than those sprayed with the paste. This result was as expected; the paste had been used because it was supposed to possess more retentive power than the wettable powder.

The need for dichlone at amounts higher than 1/4 pound per 100 gallons of spray is questionable. The conditions of this test, which involved highly concentrated inoculum under high pressure followed by 10 inches of water in 16 hours, certainly surpass any natural infection conditions except possibly those occurring during a hurricane. Yet dichlone at 1/4 pound gave control almost equal to that obtained by higher concentrations. The degree of control given under these conditions by 1/4 pound of dichlone would be excellent if translated to control achieved under conditions normally encountered in an orchard. Certainly 3/8 pound would be the highest concentration needed under any condition.

The great amount of water applied as irrigation followed by rain gave a more thorough test of the retentive power of the fungicides than would be obtained under orchard conditions One exceptional material included in the test but not reported in this paper had given good control elsewhere in an orchard test. However, in this test it gave very unsatisfactory control, probably owing to poor retentive qualities that were not detectable under the natural infection conditions of the other test. Small plots and severe artificial test conditions like those used in this test should permit development of pesticides at less cost than large plots and reliance on natural infection with undependable weather conditions.

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INCREASED VIRULENCE OF SCAB (CLADOSPORIUM EFFUSUM WINT.) DEMAREE) ON STUART PECAN IN MISSISSIPPI AND ITS PRESENCE IN LOUISIANA

John R. Cole and A. C. Gossard[1]

In October 1955, the writers made an inspection trip in Mississippi to investigate the occurrence of the scab fungus on the Stuart variety of pecans. They found the scab commercially serious on the nuts of this variety in orchards near Laurel, Lumberton, and Fruitland Park and found traces of the disease on the nuts near Gulfport[2].

During September 1956, the writers again inspected orchards where scab was present in 1955 and found that it had increased in severity at all localities. Figure 1 illustrates the severity of scab on the Stuart; these nuts came from trees where the grower had only partially followed the recommended spray schedule, making three applications of ziram rather than the six recommended.

FIGURE 1. Cluster of Stuart nuts collected in W. S. Taylor orchard near Laurel, Mississippi. Three applications of ziram had failed to control scab and these nuts are a total loss.

During the early summer of 1956, the scab fungus was found on the foliage of bearing Stuart trees in the W. S. Taylor orchard near Laurel, Mississippi, by the junior writer and was observed by both writers in the Bass orchard on nursery stock at Lumberton, Mississippi, in September.

In addition the scab fungus was found to be commercially serious on the nuts of the Stuart variety in orchards near Bogalusa and Slidell, in southeastern Louisiana. Time did not permit the location of the western boundary of scab as it affects the Stuart variety of pecans, but inspection of orchards in eastern Mississippi and western Alabama by the writers indicated that it is not yet present on the Stuart variety east of Fruitland Park, Mississippi.

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[1] Pathologist and Horticulturist, respectively, Horticultural Crops Research Branch, Agricultural Research Service, United States Department of Agriculture.

[2] Stuart pecan found to be susceptible to scab in Mississippi. Plant Dis. Reptr. 40: 156. 1956.

RECENT EXTENSIVE MORTALITY OF SCARLET OAK IN WEST VIRGINIA[1]

William H. Gillespie[2]

INTRODUCTION

In early August, 1953, reports were received of an unexplained dying of scarlet oak (Quercus coccinea Muench.) in parts of West Virginia. Examination indicated that trees of this species were dying over wide areas with symptoms suggestive of drought injury. The progress of the condition was characterized by a rapid browning and dying of the foliage. Many trees that had been making good growth for 50 to 90 years showed a marked reduction in growth for the last 6 to 8 seasons. Many affected trees have died.

A similar condition has been reported in Pennsylvania, New Jersey, and New York[3], and also was observed in parts of western Virginia during the summers of 1953, 1954, and 1956.

The cause of the disease has not been determined and theories regarding it have been diverse. No fungus recognized as likely to be a causal agent was consistently isolated from branch and twig samples collected in 1953-54-55. The apparent continued recurrence of the trouble led in 1956 to a more extensive program of research. The information presented here relates particularly to the symptoms and to the distribution of the disease.

SPECIES AFFECTED

Field observations indicate that scarlet oak is affected more than other species. In some areas red oak (Quercus rubra L.) and black oak (Q. velutina Lam.) interspersed throughout the scarlet oak are occasionally affected but in most areas they appear healthy. In one area in Hardy County similar symptoms occur on white oak (Q. alba L.) and chestnut oak (Q. prinus L.) as well as on scarlet oak. Some chestnut oak seems to be affected in Greenbrier County. Hemlock, black locust, white, Virginia and pitch pines, dogwood, serviceberry, red maple and other species growing on the affected sites show no such injury.

DISEASE DISTRIBUTION

The distribution of the condition as recognized in September 1956 is shown in Figure 1. The map was compiled after an intensive aerial survey supplemented by ground checks. Most of the affected trees are found in Pocahontas County and nearly all of the scarlet oaks observed in this county show symptoms. In one of the more severely affected areas three men spent 6 hours without finding an unaffected tree to use as a check for a growth study. Isolated trees are sometimes found and areas in which trees are severely affected vary in size up to a square mile within the approximately 400-square-mile area shown in Figure 1. Many of the affected areas seem to be larger in 1956 than they were previously and the intensity of the trouble has shown a marked increase in some of the previously noted localities.

A study of weather conditions has indicated that three periods of drought occurred during the last 5 years, in 1951, 1953, and 1955[4], but affected trees are found on all aspects and slopes. The affected trees occur mainly on the southern and western slopes of the foothill ridges. A few sites were observed where the diseased trees were chiefly in coves or on ridges and in some cases they occur in bottomland and near creeks, but a few can be found anywhere the species occur.

The overall pattern of distribution seems to follow more or less the tilted Devonian shales which have given rise to a very poor and shallow soil, but these same shales are present in the drought areas of the more northern counties where this disease is rare.

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[1] Special Survey Paper Number 1, West Virginia Department of Agriculture.

[2] West Virginia Oak Wilt Co-ordinator.

[3] Fergus, Charles L., and Joseph E. Ibberson. An unexplained extensive dying of red oaks in Pennsylvania. Plant Dis. Reptr. 40: 748-49. 1956.

[4] Tryon, E. H. Unpublished Notes.

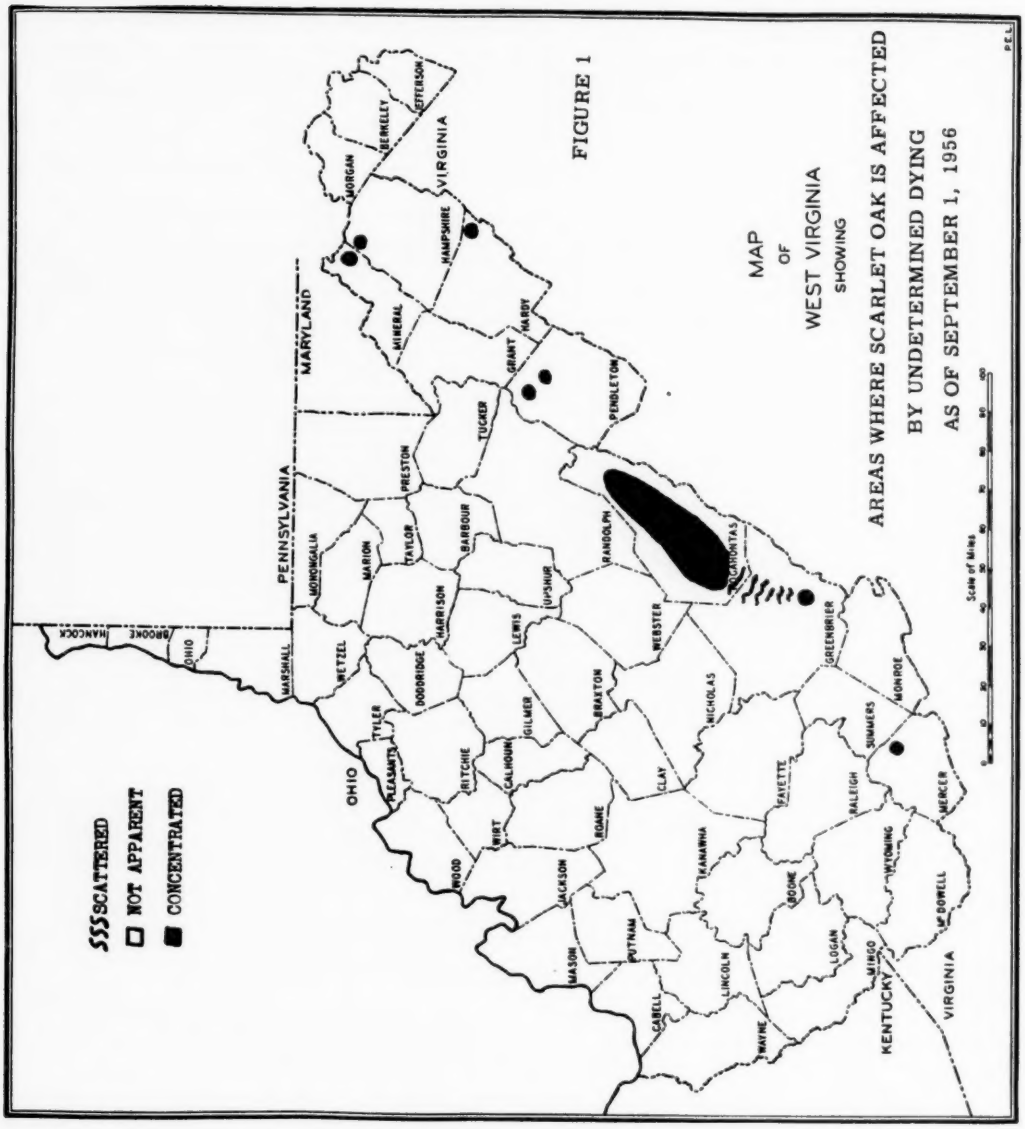
FIGURE 1
MAP
OF
WEST VIRGINIA
SHOWING
AREAS WHERE SCARLET OAK IS AFFECTED
BY UNDETERMINED DYING
AS OF SEPTEMBER 1, 1956
SSS SCATTERED
NOT APPARENT
CONCENTRATED
Scale of Miles
PENNSYLVANIA
MARYLAND
VIRGINIA
OHIO
KENTUCKY
VIRGINIA
MORGAN
BERKELEY
JEFFERSON
HAMPSHIRE
MINERAL
HARDY
GRANT
PENDLETON
TUCKER
PRESTON
RANDOLPH
BARBOUR
TAYLOR
MARION
MONONGALIA
UPSHUR
HARRISON
LEWIS
WEBSTER
RICHMOND
GREENBRIER
MONROE
SUMMERS
DODDRIDGE
BRAXTON
GILMER
CALHOUN
RITCHIE
TYLER
PLEASANTS
WETZEL
MARSHALL
OHIO
BROOKE
HANCOCK
NICHOLAS
CLAY
FAYETTE
RALEIGH
MERCER
WYOMING
WIRT
ROANE
JACKSON
WOOD
KANAWHA
BOONE
LOGAN
MINGO
MASON
PUTNAM
LINCOLN
CABELL
WAYNE
MCDOWELL

SYMPTOMS

The symptoms appear suddenly, usually during the last week of July or the first week in August. In 1956 new symptoms were not observed until the eleventh day of August. The scarlet oaks observed were mainly in the dominant and codominant classes, but in a few areas intermediate and suppressed individuals were also dying.

Symptoms have been characterized by a sudden browning and dying of the leaves in the top of the tree during the initial season with the bottom two-thirds of the crown dying during succeeding years. Generally, during the 1956 season the leaves of the entire crown turned brown and died in about 2 weeks. Leaves may be small and chlorotic, particularly near the edge of that part of the crown which died the previous year. The leaves remain attached for some time as contrasted to the premature leaf fall which characterizes oak wilt.

In all observed cases the trees that started dying in 1953 or 1954 are all dead with the bark loosening and falling off.

Affected trees may sprout from the stump, but usually do not, especially the larger trees.

Diameter growth shows a decline for as long as 6 to 8 years. An examination of the aerial parts of several dozen trees has failed to show any external indications of infection and culturing has yielded no evidence that the disease is caused by a fungus.

The condition of the roots has been given close attention because of the possibility that the disease results from some situation existing in the roots or soil. Over 100 roots were carefully dug from dead or dying trees and all roots 1/4 inch or more in diameter appeared to be alive[5].

ECONOMIC IMPORTANCE

Scarlet oak is one of the more prevalent species in Pocahontas County. The commercial value of this species is very low at present. It is difficult to arrive at a reliable estimate of the quantity of timber that has been lost, but data taken on ten 1-acre plots where the disease occurs shows an average loss of 50 scarlet oaks per acre. These were largely dominant and codominant trees, with the diameters ranging from 3 inches to 20 inches. Reproduction of scarlet oak is sparse, but a count of surviving trees shows an average of about 30 white oaks and 70 white pine per acre with varying numbers of other species which may be expected to take over now that the scarlet oak is gone.

CONFUSION WITH OAK WILT

There is very little similarity between the symptoms of oak wilt caused by Endoconidiophora fagacearum and this disease. However, a single tree which is undergoing a gradual decline is often confused with oak wilt at a distance because the top is almost bare, the middle of the crown is brown, and the bottom limbs are still green. Oak wilt was discovered in Pocahontas County in 1951, but since then none has been found. If it is still present in the county then it lies unnoticed in the midst of hundreds of dead and dying scarlet oaks.

WEST VIRGINIA DEPARTMENT OF AGRICULTURE

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[5] True, R. P. Unpublished Notes.

POSSIBLE RELATION OF DIPLODIA THEOBROMAE TO LEADER DIEBACK OF SWEETGUM SUGGESTED BY ARTIFICIALLY INDUCED INFECTIONS

Kenneth H. Garren[1]

ABSTRACT

Diplodia theobromae was isolated from sweetgum with leader dieback in southeastern United States and a Diplodia sp. from trees with sweetgum blight in Maryland. Thus Diplodia is associated with both these disorders, considered possibly a single disease by some investigators. Wound inoculations with D. theobromae induced dieback and cankers on both young sweetgums which had been grown in a low-mineral medium and young vigorous sweetgums on which the micro-environments of inoculated areas were kept hot and humid. In such micro-environment trees with induced cankers also developed dieback. The possibilities that a low-mineral environment predisposes trees to infection and that cankers may be forerunners of leader dieback are suggested as points that need investigation in the field.

INTRODUCTION

Diplodia spp. are well-known inhabitants of lumber and of the organs of plants in which food accumulates. Diplodia spp. do attack other types of plant tissue, but in many such instances a predisposing weakening of the host is indicated. Therefore Diplodia spp. are generally labeled "weak parasites." In 1942 Voorhees (8) partially clarified the taxonomy of this group of ubiquitous fungi when he included 15 species of the form genera Diplodia, Lasiodiplodia, and Botryodiplodia in the synonymy of Physalospora rhodina (Berk. & Curt.) Cke. There is some unpublished opposition to Voorhees' contention that Diplodia gossypina Cke. is in this complex; thus D. theobromae (Pat.) Now. is the most acceptable name when one wishes to refer only to the conidial stage of this fungus.

For several years the writer investigated various aspects of the pathogenicity of Diplodia spp. More recently the investigation has been primarily concerned with a Diplodia sp. and a dieback of sweetgum (Liquidambar styraciflua L.) (2, 3). During this period the possible relation between Diplodia spp. and sweetgum stem necrosis has become part of the complex problem of sweetgum dying in the southeastern United States. Recognition of this problem has developed as follows:

A sweetgum disease was first observed in Georgia and Alabama; it was described and named "leader dieback" in 1949 (2). Several fungi were isolated from the necrotic sweetgum stems, but a Diplodia sp. and a Nectria sp. offered most promise as pathogens. The specific identity of the Diplodia sp. was not apparent until recently when cultures exposed to natural light sporulated regularly and uniformly on V-8 juice medium (5). It is now identified as D. theobromae.

In 1951 Miller and O'Brien (7) described a sweetgum dying in Maryland which they named "sweetgum blight." They concluded that the symptoms of leader dieback as described in 1949 (2) differed materially from the symptoms of the condition in Maryland and they noted the order of frequency of fungi isolated from woody tissues of trees with sweetgum blight as "Diplodia, Trichoderma, and Penicillium." A 1952 report by Miller and Gravatt (6) enlarged the description of sweetgum blight. Berry (1) isolated no one fungus consistently from trees with sweetgum blight and his inoculations with Diplodia sp. and other fungi produced no sweetgum blight symptoms in two years. He analyzed leaves from healthy and diseased sweetgums and found no significant difference in the concentration of ten elements which included potassium, phosphorus, and the essential trace elements.

Hepting (4) in 1955 reported on a survey of sweetgum blight which distinguished between "blight" and "dieback" whenever it was possible to do so and which considerably extended the range of both types of sweetgum dying. Hepting noted that similarities between the symptoms of leader dieback and sweetgum blight sometimes made it impossible to distinguish between them. He noted further that the cause of neither disorder is known, thus there is no proof that

[1] The writer began this investigation while a member of the teaching staff of the Alabama Polytechnic Institute and he wishes to acknowledge the financial support received from the Grant-In-Aid Fund of that institution.

sweetgum blight and leader dieback are different diseases.

It is hoped that the results of the investigation of the pathogenicity of D. theobromae given herein will make some contribution to the eventual solution of the complex problem of sweetgum dying.

PROCEDURE AND RESULTS

Attempts to reproduce leader dieback by inoculation with either D. theobromae or Nectria sp. under "natural conditions" met with no success; consequently, a series of small-scale experiments was planned. The objectives were to determine whether D. theobromae could incite a dieback of sweetgum stems under conditions not conducive to a similar action by Nectria sp. and whether there are predisposing conditions under which the dieback developed more readily. The experiments consisted of inoculations of young sweetgum trees given various pre-inoculation treatments. The results are summarized in Table 1 but a few details of results are included in the following description of procedures:

Four- or five-year-old sweetgums were obtained. All except for test 2 were transplanted to large clay pots containing soil from forest areas. For test 2 some 3-year-old trees were transplanted to washed quartz sand in earthenware crocks after their roots had been thoroughly washed with tapwater, and they were watered with tap water but given no fertilizer or additional minerals for 18 months before inoculation. All trees were transplanted at least 6 months before the experiments were started. The thermostats in the greenhouses in which the tests were conducted were set for 80° F. Night temperatures rarely dropped below 80°. The plants were shaded in the summertime, but daytime temperatures frequently reached 90° and on a few occasions 100°.

Inoculations, except in test 7, were made on the leader 8 inches below the terminal bud. The leaders were prepared for inoculation in wounds in one of two ways: either a 1/4-inch by 1/16-inch area of bark was scraped off with a sterile scalpel (tests 1 and 2) or the leader was cut on a slant to the pith with a sterile scalpel (tests 2, 3, and 4). Active cultures of transfers of isolates from tissues affected with leader dieback were used as inocula. They were grown on either malt agar or V-8 juice medium. The cultures of D. theobromae were originally isolated in Alabama and North Carolina; the Nectria sp. isolates were from Alabama as was the unidentified sterile gray fungus. Inoculum was placed in the wounds of tests 1 through 4. The unwounded trees for test 6 were inoculated by tying strips of inoculum to stems. For test 7 sporulating cultures of D. theobromae were made into a suspension in a Waring blendor and this suspension was sprayed on current season's growth of leaves and stems. All inoculated areas, except in test 7, were covered immediately with sterile moist cotton and then either a sleeve of pliofilm was fastened loosely around the area (tests 1 and 2) or the terminal 12 inches of the leader was enclosed in a pliofilm bag (tests 3 through 7). The sleeves were removed in 120 days and the bags were removed in 21 days. The trees for test 7 were enclosed in bags immediately after inoculation and the trees were kept at a temperature never over 90° for the first 3 days. Thermometers inserted in a few of the bags indicated that daytime temperatures inside the pliofilm varied from 3° to 10° above air temperatures.

In all tests the checks were given identical treatments except that no inoculum was used.

If the leader died following inoculation 1/4-inch segments were used in attempts to isolate the fungus used as inoculum. These were taken at 1-inch intervals. The first segment taken included the terminal bud and the last necrotic tissue plus adjacent living tissue. If the fungus was isolated from the last segment and also from the majority of the other segments the introduced fungus was regarded as having induced the dieback.

All inoculated trees which did not develop symptoms of infection were examined at the end of 4 months and in all instances either the lesions were healed completely or a good wound callus was formed in the cuts. Nevertheless all of these trees were kept an additional 2 months before they were considered not infected and discarded. In test 2 two trees inoculated with D. theobromae had open cankers at 4 months. The leader of one of these trees died just after the buds opened in the spring. In all three of the trees of test 2 which developed dieback internal stem necrosis extended for about 2 inches below the point of inoculation and D. theobromae was isolated from the necrotic tissue. At the end of 13 months the canker on the tree inoculated with D. theobromae which did not develop a stem necrosis was still open and D. theobromae was isolated.

For test 5 the leaders of the five trees of test 3 and the one tree of test 4 which developed open cankers but no dieback were enclosed in pliofilm bags for an additional 21 days. At the end of that period two of these trees were found to have dieback and 3 days later two more

Table 1. Dieback development in young sweetgum trees treated variously before and after inoculation with Diplodia or other fungi.

Test No., tree description, inoculating fungus	Number trees: Inoculated	Developing typical dieback	Developing cankers	Days required for dieback to develop
1. Wounded vigorous trees:				
Diplodia theobromae	8	0	0	
Nectria sp.	4	0	0	
Unidentified fungus	2	0	0	
None	4	0	0	
2. Wounded trees growing in low-mineral medium:				
Diplodia theobromae	4	3	1	50, 50, 210
Nectria sp.	4	0	0	
Unidentified fungus	2	0	0	
None	4	0	0	
3. Wounded vigorous trees with bagged terminal portion:				
Diplodia theobromae	9	4	5	11, 32, 90, 100
None	4	0	0	
4. Severely wounded trees with bagged terminal portion:				
Diplodia theobromae	4	3	1	15, 21, 32
None	4	0	0	
5. Bagged cankered trees:				
Diplodia theobromae	6	4	-	21, 21, 25, 25[a]
6. Unwounded vigorous trees with bagged terminal portion:				
Diplodia theobromae	6	4	0	32, 32, 66, 123
None	4	0	0	
7. Unwounded vigorous trees with portion bagged:				
Diplodia theobromae	4	0	0	
None	2	0	0	

[a] The time for dieback to develop in test 5 is given in days from beginning of test 5. These plants were inoculated with Diplodia theobromae 100 days before the beginning of the test.

leaders had developed it; D. theobromae could be isolated from all four.

DISCUSSION AND CONCLUSIONS

No infection developed after inoculation with the Nectria sp. in tests 1 and 2; consequently the investigation was continued with D. theobromae only.

Some infection was produced through wounds when high temperatures were associated with a saturated atmosphere for a prolonged period. Infection was obtained under the same environmental conditions when the inoculum was brought into contact with cut ends of vessels, but there were not sufficient trees to permit evaluation of percentages of infection. The development of cankers rather than dieback in some trees indicated that cankering was an important expression of induced infection by D. theobromae and in two of the tests (2 and 5) some dieback developed on leaders with induced cankers. All-in-all the results suggested that D. theobromae was pathogenic only under two sets of rather limited conditions, namely 1) disturbance of the mineral balance and 2) sustained high temperatures and saturated atmosphere.

The results in general indicated that something other than small natural wounds such as leaf scars and lenticels were required for penetration and establishment of D. theobromae in the sweetgum stem tissue. However, the results of test 6 were inconsistent with this viewpoint. If any of the uninoculated trees of test 6 had developed dieback one might suspect that part of the trees used were already infected when inoculated, but from the results obtained one must conclude that D. theobromae sometimes penetrated and incited dieback of young stems which had not been artificially wounded. Possibly the application of a strip of culture made for an unusually vigorous source of inoculum, since the bits of hyphae and spores used as inoculum in test 7 were unable to effect a similar degree of penetration and establishment.

The dieback which developed in these tests was typical dieback but application of the results to consideration of natural development of dieback must be somewhat indirect. Some wounds similar to the non-severe type of tests 2 and 3 may be found on trees in the field and the writer has found associated with leader dieback a few cankers from which D. theobromae was isolated. Neither prolonged periods of macro-environment similar to the micro-environments of tests 3 through 7 nor the vigorous inoculum of test 6 are likely to occur in nature. Thus while a dieback of sweetgums was induced by inoculation with D. theobromae only two obviously valid leads on natural development of leader dieback of sweetgum were suggested. These were: 1) that a low-mineral medium may be a predisposing factor in leader dieback development and 2) that D. theobromae can incite cankers some of which may be forerunners of leader dieback. Either of these possibilities is in keeping with the widespread contention that if and when Diplodia spp. are parasitic they are weakly parasitic.

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HORTICULTURAL CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE; VIRGINIA AGRICULTURAL EXPERIMENT STATION COOPERATING (TIDEWATER RESEARCH STATION, HOLLAND, VIRGINIA)

NOTES ON MYRIANGIALES IN FORMOSA. I.

Ping-Chao Chen[1]

A preliminary annotated list of the described species of Elsinoë and Sphaceloma thus far discovered in Formosa is here presented. In addition Sphaceloma sp. is reported on a new host.

ELSINOË AMPELINA Shear (19).

On Vitis vinifera

In recording this fungus in Formosa, Sawada (17, pt. 8: 78) did so under the imperfect stage name Sphaceloma ampelinum D By.

ELSINOË BATATAS Viégas & Jenkins, in Jenkins and Viégas (11).

On Ipomoea batatas: Hong-rang, Taipei Prefecture, October 11 and 25, 1950, P.-C. C. Perfect stage. Ascomata abundant on petioles, measure 125-230 μ in diam. by 43-89 μ in thickness. Asci are 16-24 x 13-21 μ, and ascospores 12-16 x 3.5-6.4 μ. (Fig. 1).

This organism was described from Formosa as Sphaceloma batatas Saw. (17, pt. 5: 105), then described from Brazil as E. batatas.

ELSINOË CANAVALIAE Rac. (16, pt. 2).

On Canavalia ensiformis: Taitung March 17, 1944, K. Sawada (9).

In noting that the label of Sawada's specimen gives the host as C. ensiformis, Jenkins and Bitancourt explained that E. canavaliae was described on C. gladiata, and that as yet it is not known for certain that C. ensiformis is a host of this Elsinoë. For further explanation they cite Jenkins (6: 1, 2).

ELSINOË CINNAMOMI Pollack & Jenkins, in Limber, Pollack and Jenkins (15).

On Cinnamomum camphora: Mt. Hong-rang-shang, Taipei Prefecture, October 18, 1954, P.-C. C. Determined and recorded by Jenkins and Bitancourt (9).

ELSINOË FAWCETTI Bitanc. & Jenkins (1).

On Citrus spp.: Taipei Prefecture, May 2, 1949, P.-C. C.

An original study of sour orange scab in Formosa is that by Sawada and Kurosawa (18).

SPHACELOMA ARALIAE Jenkins (7).

On Agalma lutchuense: Mt. Seanconmeaou, Taipei Prefecture, February 20, 1955, P.-C. C. New host genus and species (Fig. 2).

On Tetrapanax papyrifera: Taichung Prefecture, December 28, 1955, P.-C. C. New host genus and species. (Fig. 2).

Sphaceloma araliae, described on Aralia spinosa from the United States, has been recorded from Japan on A. chinensis (9), Fatsia octophylla (13).

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In assembling the present compilation the writer acknowledges with pleasure the collaboration of Dr. Anna E. Jenkins, International Cooperation Administration, United States of America, care of American Consulate General, São Paulo, Brazil, and of Dr. A. A. Bitancourt, Instituto Biologico, São Paulo, Brazil.

Thanks are also due to Prof. T. Matsumoto, National Taiwan University, for his constant encouragement during the course of study.

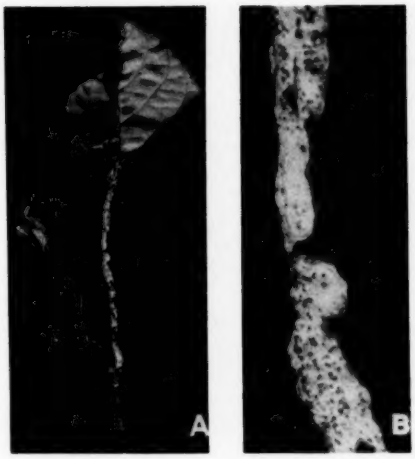

FIGURE 1. Elsinoë batatas on sweet potato. A, x about 3/8; B, part of petiole in A, showing numerous dark ascomata, x about 3 3/4.

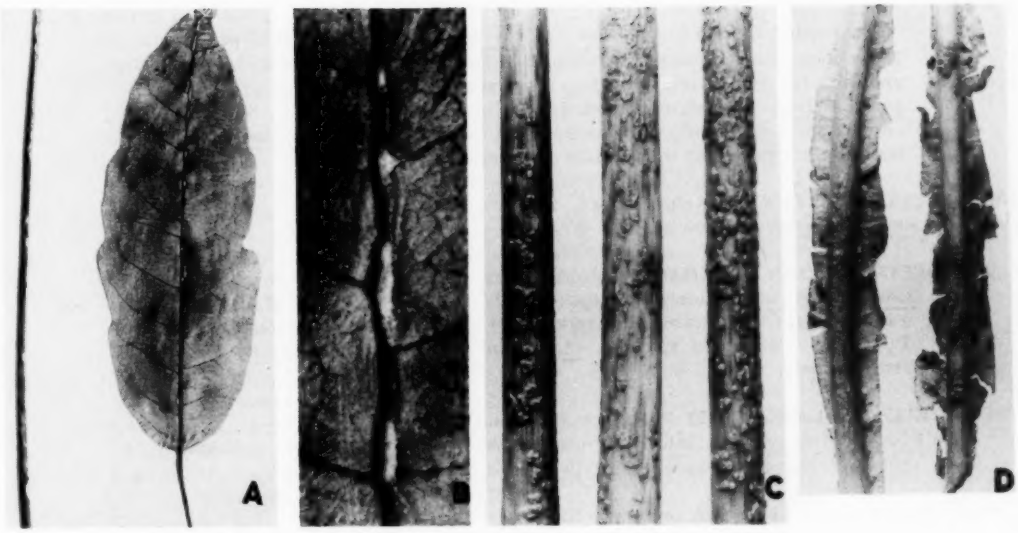

FIGURE 2. Sphaceloma araliae. A, on stem and midrib of Agalma lutchuense, x about 1 1/8. B, lesions on midrib in A, x about 2 1/4. C and D, on stems (C) and midrib of leaves of Tetrapanax papyrifera. Both x about 3/4.

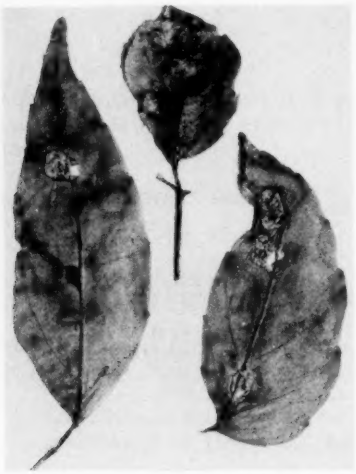

FIGURE 3.
Sphaceloma viticola on
Vitis shifunensis.

SPHACELOMA ASCLEPIADIS Bitanc. & Jenkins (2).
On Asclepias curassavica.

Recorded from Formosa as Spaceloma sp. by Sawada (17, pt. 9: 156), then from his description of the scab lesions on stems, leaves, and petioles recognized by Bitancourt and Jenkins (2) as apparently S. asclepiadis. Available material from Formosa collected by Sawada corresponds definitely with an authentic specimen of S. asclepiadis from Brazil contributed by Bitancourt and Jenkins.

SPHACELOMA ASTERIS Sawada (17, pt. 8: 78)[2].
On Aster subulatus.

SPHACELOMA BIDENTIS Bitanc. & Jenkins (3).
On Bidens bipinnata: Taichung August 22, 1944, K. Sawada, and Taichung Prefecture, August 25, 1953, Nangtaou Prefecture, August 21, 1956, P.-C. C. New host species. S. bidentis was described on B. pilosa from Brazil.

SPHACELOMA PLANTAGINIS Jenkins & Bitancourt (8).
On Plantago formosana: Mt. Hong-rang-shang, Taipei Prefecture, January 18, 1954, P.-C. C.

SPHACELOMA RICINI Cheo & Jenkins, in Jenkins and Cheo (10).
On Ricinus communis.

SPHAECLOMA TSUGII Hara (5).
On Paulownia kawakamii?: Taichong Prefecture, August 22, 1955, P.-C. C.

S. tsugii was described from Japan on Paulownia, presumably P. tomentosa Sieb. & Zucc.

[2] This species was published without aLatin diagnosis as was noted by Commonwealth Mycological Institute (4). Apropos of the footnote on page 237 of the reference just cited, we affirm that Sawada's original description of Sphaceloma asteris is as here cited.

SPHACELOMA VITICOLA Sawada (17, pt. 10: 62).

On Vitis shifunensis: Mt. Seanconmeaou, Taipei Prefecture, October 9, 1952, P.-C. C. Determined and recorded by Jenkins and Bitancourt (9). (Fig. 3).

In describing this species on V. shifunensis from Formosa, Sawada cited specimens dating from 1907 to 1943.

SPHACELOMA sp.

On Centella asiatica, leaves and stems: Ping-Tieng, October 24, 1954, P.-C. C. Organism isolated from this new host for Sphaceloma and grown in pure culture.

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SOME CORRECTIONS

September REPORTER, article by R. W. Leukel and R. W. Earhart, pages 785-787: in the list on page 785 the composition of "Setrete" should be "phenyl Hg acetate", not lactate.

November REPORTER, article by H. W. Guengerich and D. F. Millikan, pages 934-938: On page 936 the order is wrong. The first four paragraphs should all be under "Experimental Results" whereas the paragraph beginning "In 1955, the test was repeated" etc., is the last part of "Experimental Methods". The correct order on this page is thus: The paragraph "In 1955" etc., the heading "Experimental Results", the sentence "The results of the 1954-1955 test" etc., the paragraph "Without exception" etc., the sentence "The results of the 1955-1956 test" etc., the paragraph "Virginia Crab test trees" etc., and the paragraph "As an additional confirmation" etc.

On page 937, in Table 2, the first figure in the last column should be 0 instead of 6, thus the line should read: Stock, Virginia Crab A, Bud source (inoculum) Golden Delicious A, Total No. of trees 6, No. of trees inoculated 6, No. of trees pitted 0.

November REPORTER, article by Arthur W. Engelhard, pages 1005-1009: On page 1005, in the second paragraph of the abstract, lines 7, 8, and 9, reading, "All inoculated trees, whether they received salt 1 week prior to inoculation or 1, 4, or 6 weeks after inoculation, wilted.", should be changed to read, "All inoculated trees, whether they were inoculated 1 week prior to the application of salt, or 1, 4, or 6 weeks after the application of salt, wilted."

Plant Disease Epidemics Special Publication No. 9 "Spread of Puccinia polysora with a bibliography of the three rusts of Zea mays", April 15, 1956: the page numbered 17 should be 18, and the page numbered 18 should be 17. Because of the mistake the distribution of Puccinia polysora and Angiopsora zeae was confused. The correction will put them in the proper order.

IN THIS ISSUE (continued)

describes a yellows-type disease of Vinca found in Mexico, similar to but distinct from aster yellows, page 1109.

Ornamentals (see also antibiotics, virus): Varietal reaction suggests the possibility that a new race of Puccinia iridis may have been concerned in an outbreak of rust observed in a Dutch iris variety test in North Carolina in 1954, reported by N. N. WINSTEAD et al., page 1112. Occurrance of Ovulinia flower spot on azalea on Long Island, New York, is reported by PAUL E. NELSON et al., page 1115. Hot-water seed treatment was effective for control of a troublesome root rot complex of bird-of-paradise plants, according to RICHARD D. DURBIN, page 1116.

Fruit Crops: PATRICK M. MILLER recommends use of aluminum foil to increase success of inoculation with Physalospora on apples, page 1117; he also describes experimental methods for testing effectiveness of apple scab control under conditions favoring severe infection, page 1118. Pecan scab on the Stuart variety was more severe in Mississippi and was found in Louisiana in 1956, according to JOHN R. COLE and A. C. GOSSARD, page 1120.

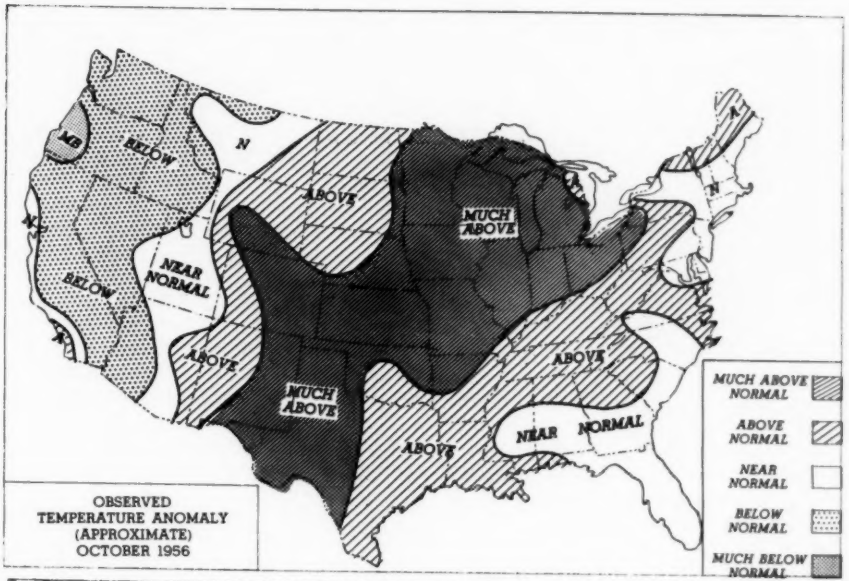
Tree Diseases: WILLIAM H. GILLESPIE describes symptoms accompanying extensive dying of scarlet oak, cause unknown, in West Virginia, page 1121. Leader dieback of sweetgum may result from infection by Diplodia theobromae under certain predisposing environmental conditions, according to successful inoculations reported by KENNETH H. GARREN, page 1124.

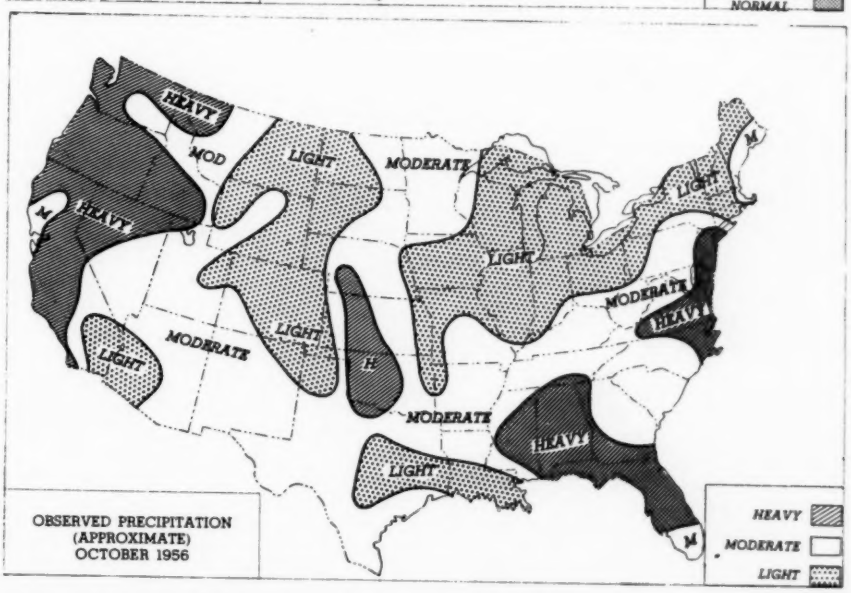
PING-CHAO CHEN has compiled a preliminary list of species of Elsinoë and Sphaceloma occurring in Formosa, page 1128.

Some corrections, page 1132.

October weather, page 1133.

Manuscripts for the Reporter, page 1134.





The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.

MANUSCRIPTS FOR THE PLANT DISEASE REPORTER

(See also PDR 35: 121-122; 36: 214, 494)

(1) GENERAL: The Reporter page measures 9 inches long with the heading or 8 3/4 inches for the text part, by 6 inches wide. The copy is typed on a larger page, 11 1/4 inches of text or 12 inches overall in length by 8 inches in width, and reduced 25 percent in the photographic process of reproduction. Illustrations or tables larger in either dimension will take a correspondingly greater reduction. Only one size of type is available for text, footnotes, or tables.

(2) MANUSCRIPTS should be the original ribbon copy, not carbons, clearly typed and double-spaced throughout, including tables, footnotes, and bibliographies. (Note -- only one copy is needed.) Footnotes should be typed at the bottom of the page.

(3) ABSTRACTS are requested for all except very short articles. (PDR 38: 316).

(4) CAUSES OF DISEASES should be named. For bacteria, fungi, nematodes, etc., give the Latin name of the organism; for viruses either or both the accepted common name of the virus or a Latin name if you prefer it and there is one; for non-parasitic diseases state the causal factor if it is known. If the cause of a disease has not been determined say so. (PDR 36: 494).

(5) LITERATURE REFERENCES should be given in alphabetical order and numbered for citation in the text. We follow the AIBS suggestion of placing the year of publication after the author's name. Please check your titles carefully since we cannot do it for you. Be sure that text citations and bibliography agree; that foreign-language references are correct; that number or month is cited for periodicals that are not paged consecutively throughout the volume.

(6) NAMES OF FUNGICIDES should be given according to the suggestions that will be published in Phytopathology before long, and later repeated in the Reporter. In the meantime see PDR 35: 122.

(7) ILLUSTRATIONS should be sent to us unmounted. To prevent mistakes, write figure numbers on the back, and mark the top of each print when necessary. A sketch can show a preferred arrangement but please keep in mind page size, shape, and standard reduction (see above under General), and remember that figure titles and legends are part of the page. Lettering should be clear and large enough to be legible after reducing. Drawings, maps, and graphs can be photographs or originals, but should be finished and ready for reproduction, not just sketches.

(8) TABLES should be carefully thought out with particular attention to the Reporter's limitations in reproduction. Make titles and headings definite and self-explanatory. Designate footnotes in tables with superscript lower-case letters. Be sure that text discussion agrees with the data in the table. Do not abbreviate names of crop varieties.

(9) REPRINTS cannot be supplied since there is no way in which we can be reimbursed. However,

(10) The MULTILITH PLATES from which reprints can be made will be sent if requested at the time the article is submitted. The press size of these plates used for the Reporter is designated as small -- maximum image 9 1/2 by 13 inches, maximum paper size 9 3/4 by 14 inches -- for Model 1250. Most of the Experiment Stations have this type of multilith machine.

(11) We are the official correspondents in the United States of the PLANT PROTECTION BULLETIN published monthly by the United Nations Food and Agriculture Organization. We would appreciate it if plant pathologists would send us suitable material from time to time for inclusion in our monthly summary reports. Please mark it clearly so that we will know it is intended for the Bulletin. (See PDR 36: 492; 37: 637) -- P. R. M.